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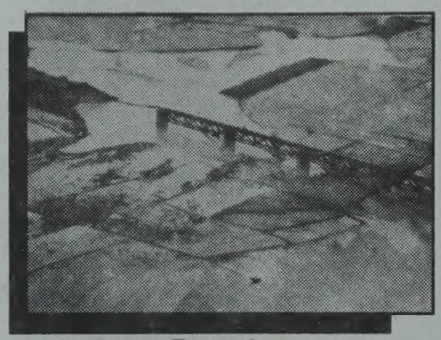
PALLAVA BAGLA

Recounting the success story of rural automatic exchanges that have integrated far-flung villages into the telecom network



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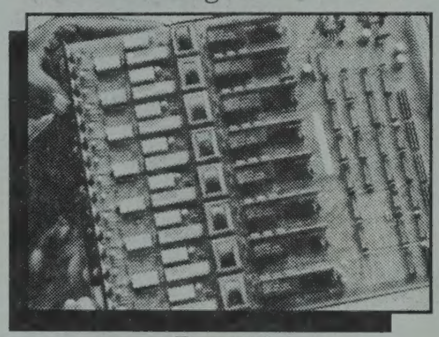

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SCIENCE REPORTER
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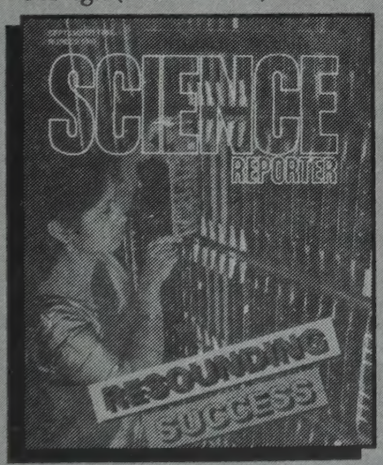
Editorial: 578-8702
Production: 573-0147 Sales:578-5359
Fax: 573-1353 Telex: 031-77271 PID IN
E. Mail: pid @ sirnetd.ernet.in
Science Reporter is published monthly. Publications and Information Directorate (CSIR) assumes no responsibility for statements and opinions advanced by the authors.
Subscription (inland):
1 yr.-Rs. 50.00, 2 yrs.-Rs. 90.00
3 yrs.-Rs. 125.00
Foreign (Surface Mail) - US $ 15



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Text Layout: K. B. Dhingra

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Hope For The Future

INDEPENDENCE day celebrations are not merely occasions of revelry but of introspection. What has our science and technology enterprise done in the last forty six years since independence — a time period spanning three generations? Or have we done anything at all? Intriguing though these questions are, they are routinely being bandied by a section of the public which persistently views the achievements of Indian scientific community with skepticism. They often cry hoarse that science in India is widening the gulf between the haves and have-nots, instead of building a bridge. That the fruits of labour of the scientists in India are only reaped by a select few, and the needy are kept away from it. That science and technology is not helping the rural poor.

There can be nothing further from the truth. For example, this month's cover story shows clearly what modern technology can do to improve the lot of rural people. Not only that, our achievements in the field of agriculture have increased the per capita availability of food. Similarly, achievements in health-care and medicine have reduced the price of drugs many times. Yes, one can not discount the criticism that science is practised in closed quarters, away from the public gaze most of the time. But to say that scientific research or technology development in India is, for the most part, elitist and carried inside ivory-towers, is certainly not the whole truth.

To let the idea that science has let down the rural masses take root in the populace is itself a mistake, one that needs to be remedied soon. One way of doing that is through popularisation of science. But it is done better through proper education. Unfortunately science education in India has come to stand for obtaining highest marks in a particular exam, rather than being the arouser of inquisitiveness that it is supposed to be. Unless this is sorted out, science making a dent in to the psyche of rural masses will remain a hope only.

Reactions

Right To Live

I write this letter to seek *urgent* help from you, and through you, from others championing the cause of the tribal people.

For the first time in two centuries, the administration of the Andaman and Nicobar Islands has taken a very positive decision that will go a long way in protecting the tribes of the Andamans, particularly the Jarawas, one of the last hunter-gatherers in the world. The decision is to stop issue of live ammunition to the Bush Police, Forest Protection Force and also other officials. We believe that this would bring about a qualitative change in the behaviour of the Bush Police and the Forest officials who have had many unwarranted skirmishes and confrontations with the Jarawa, leading to countless deaths of these tribals, a few reported, but most, unreported. Depriving the forces of the live ammunition would have an effect like depriving the serpent of its fangs.

The raw money power of the loggers and poachers has always been a corrupting force on the minor officials. These law-breakers have traditionally worked in connivance with and under protection of the Bush Police and the Forest Protection Force. In the new circumstances they would lose their faith in the ability of the officials to protect them. Consequently, logging, poaching and encroachment in the Jarawa Reserve will probably stop or at least get substantially reduced.

In another decision, the Administration has drastically reduced the total number of firearm licenses in the whole of the Islands and particularly in the area around the tribal reserves. The regulations for keeping the live ammunition has been changed to make possession of more than 10 live cartridges at any one time, subject to a total procurement of more than 50 cartridges in one whole year, illegal. This too is a welcome gesture, particularly in view of reports of raids in the Jarawa areas to collect artifacts for sale to foreign tourists.

These very welcome decisions of the Administration can be credited to the present Chief Secretary. These decisions, though implemented, have not yet been widely publicised. We fear that the Administration will be pressed hard to countermand these decisions by vested interests, including loggers, poachers and greedy politicians. We feel that if a large number of concerned individuals openly welcome these decisions and congratulate the administration, the powers-that-be would find it difficult to put the clock back.

Samir Acharya
Andaman and Nicobar Islands

Selling Culture

The cover story ***India's Supercomputers*** *(SR,* August 1993) by Biman Basu was about an achievement we Indians are sure to be proud of. But the truth remains that the Indian market is still a little slack. The problem is that people still want to buy things from abroad. The problem also is that most scientists believe that selling is against their culture. It is clear that if sustained efforts are not made in the next ten years or so our supercomputers will disappear superfast.

Abhijeet Chowdhary
Dehradun (U.P.)

Sci-fi Disappears

There has been a conspicuous absence of any science fiction story in the issues of *Science Reporter* after February 1993. Science fiction is one of the creative arms of science, in fact much good science fiction has a very limited shelf-life because many 'fictional' concepts introduced turn into facts !

In India there is a lack of effective popularisation of sci-fi. The only national science magazine that supported sci-fi was *2001* (of the Times of India Group). Unfortunately it has shut down. The onus now rests on *Science Reporter.*

Kaushik Ghosh
Bombay (Maharashtra)

A Matter Of Brains

Shocked I am after reading your ***In Focus*** column in the July 1993 issue of *SR.* I am not able to understand why engineers and doctors should not opt for administrative services. Why do you want second or third rate brains only to become administrators and allow them to sit on the head of first rate brains that the engineers or doctors are supposed to be ?

In the era of science and technology, it is only desirable that we have people who understand science and technology to plan and execute schemes of National Development.

Can I request you, Sir, to find out the quality of life that a bureaucrat enjoys and compare it with that of a doctor or engineer serving a public enterprise. The plea that the society spends money to train a doctor and engineer is poor logic. Such costs are immediately recovered with better decisions and solutions that the technocrat-turned-administrator will be giving.

If one goes by your plea, no educated person should ever become a politician. But we find that the members of technocracy as well as that of bureaucracy are only too eager to join national politics. I only hope that such a trend will only make our polity more vibrant.

A. Kandpal
Vadodara (Gujarat)

II

Apropos your editorial ***Pride and Prejudice*** in the July issue of *SR,* a lot of grumbling is on about the mega performance by engineering students in the Civil Services exams. There is nothing wrong with engineers going to CS. As far as the wastage of talent and money is concerned let me point out that there are engineers

Reactions

going abroad in even greater numbers; there is hardly any attempt to arrest this trend. It is said that the lure of power attracts the engineers but then what is it that is pulling the non-engineering students and hasn't one heard before of scientists taking to politics, athletes to acting and so on and so forth ? As far as the job deprivation factor is concerned the overall scenario remains the same, since there are employed engineers too. Your title, 'Pride and Prejudice', suggests that the selectors at the UPSC are more inclined towards choosing engineers. It is just by their talent combined with hard work that the engineering students secure good positions.

Vikram Chandna
Allahabad (U.P.)

Life In Test-tubes

The article *In Search Of Life* (*SR*, August 1993) by Sukanya Datta was very informative. Till now I had only heard about test-tube babies. This was the first time I came across a full-length article on this subject. It was interesting to know about Louise Brown, the first test-tube baby. I hope you carry on with the good task of bringing to us detailed articles on such novel topics.

Baby Pattnaik
Cuttack (Orissa)

Mathematics

The article *Journey Into Mathematics* by Nakul Parashar (*SR*, July 1993) was very interesting. It was after a long time that an article on maths was so very well highlighted. The article can be very useful for anyone interested in learning the basis of discrete mathematics.

Ch. A.V. Prasad
Bombay (Maharashtra)

Brains Trust

A small error has crept in in the answer to the question on rainbows in the *Brains Trust* column. The angle for blue colour should have been 40.6 and not as printed.

Editor

BRAINS TRUST COUPON SEPTEMBER 1993

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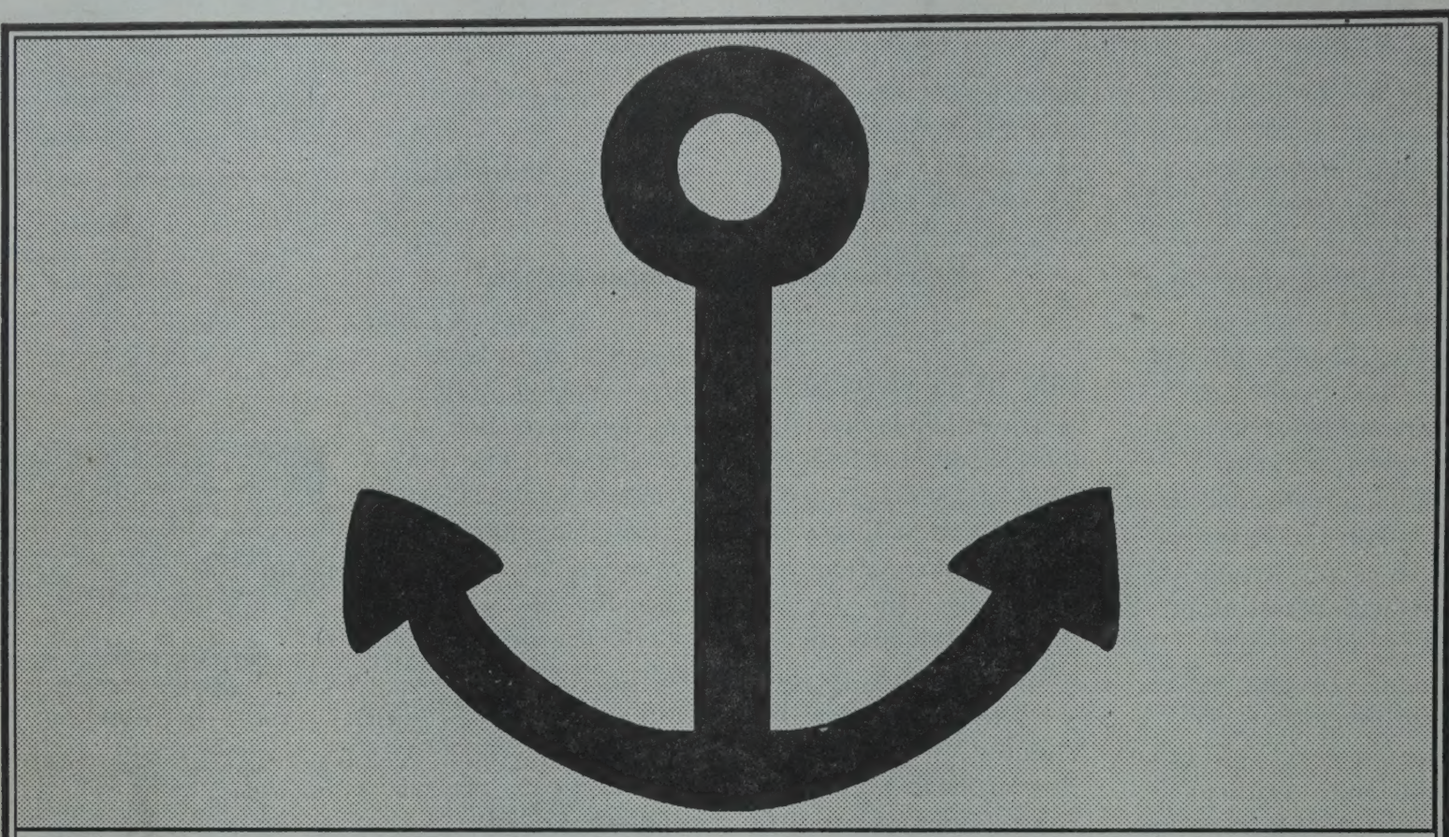

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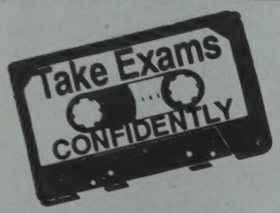

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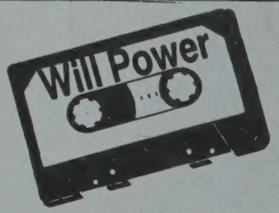

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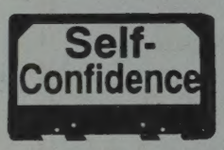

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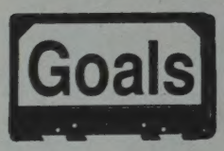

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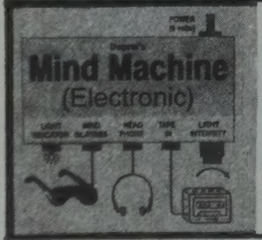

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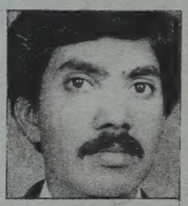
About Dr Anil Bapna's Mind Power Music™



Dr Anil Bapna, Ph D, is the creator of the Mind Power Music. This music is based on scientific research into how the mind works and how to program and control it for our own success.

The Mind Power Music has no voice but only musical sounds and also sounds from nature such as river or birds etc. This music is very relaxing.

This music contains Hidden-Messages™ which bypass your conscious mind and go directly to your subconscious mind, and change your behaviour. This is why the change and improvement with Mind Power Music is so easy and effortless. All you have to do is listen to Mind Power Music.

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Please write item code number for cassette courses or special discount offer. Write address, PIN neatly in English CAPITAL letters. For MO, please also write your address in "Space for Communication" at bottom of MO form.

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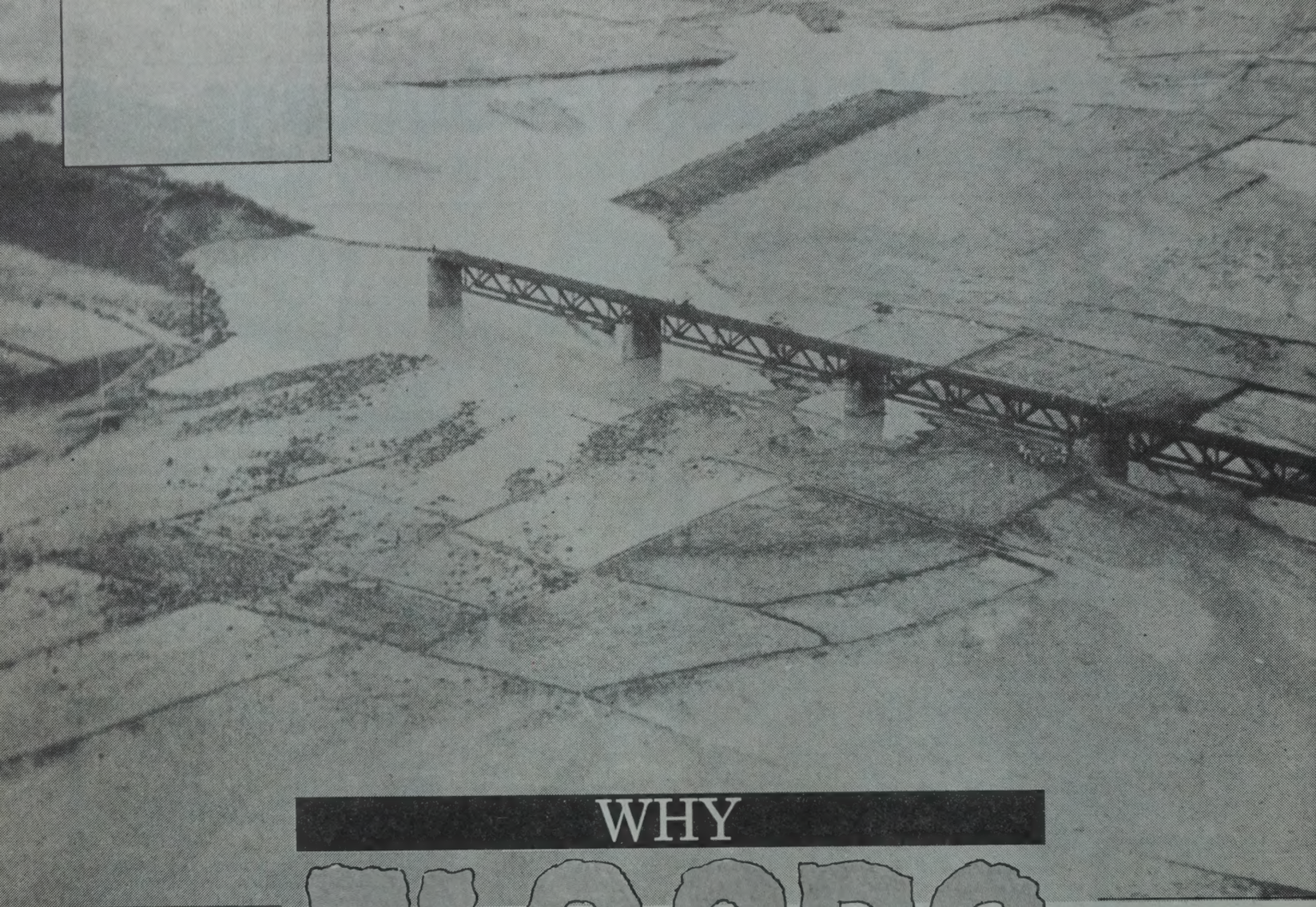


WHY FLOODS RECUR

A better understanding of behaviour of rivers could help prevent floods, says *BIMAN BASU*

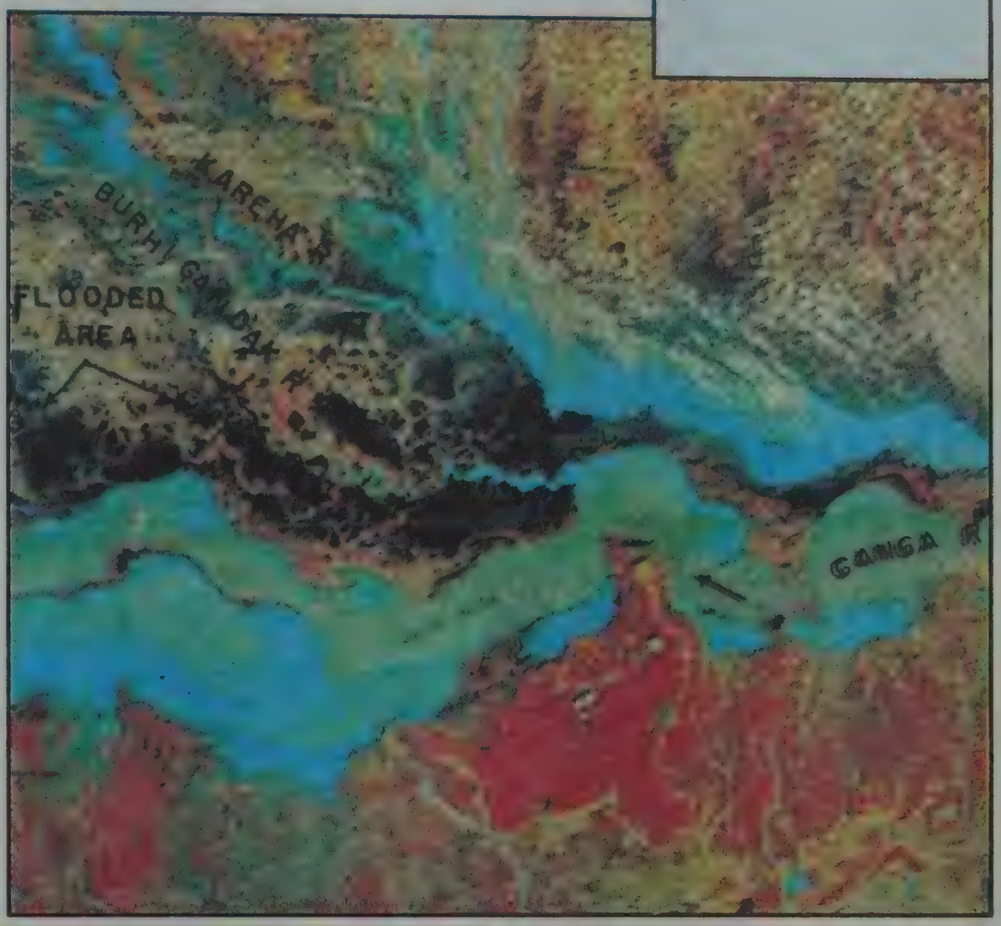
FLOODS, the deluge caused by swollen rivers with overflowing banks, are an annual feature in India. Every year, damages and loss of property caused by floods run into thousands of crores of rupees. But worst of all, precious lives are lost in hundreds. What is most surprising is that despite crores of rupees spent on flood control measures every year, the losses keep mounting although the figure may fluctuate from year to year.

According to figures currently available, the total value of losses due to damage to crops, houses and public utilities, which was around Rs 57.24 crores in 1954 went up to a staggering Rs 4059.25 crores in 1985. Last year, according to an estimate of the Central Water Commission the losses amounted to Rs 832.22 crores, down from Rs 1456.33 crores during 1991. Surprisingly, the total area affected has varied only between 7.49 million hectares in 1954 to about 10 million hectares on an average during the last few years; the only exception was in 1978 when the total area affected exceeded 17 million hectares. The loss of human lives has also remained more or less within the range of a few hundred per year not counting the year 1977 during which as many as 11,316

lives were lost due to floods.

One must remember, however, that besides the direct losses in terms of loss of life and property, indirect losses resulting from the breakdown of communication, disruption of rail and road traffic and other essential services may be equally staggering; their restoration may cost crores of rupees.

THERE are basically two major causes of floods in India: floods due to cyclonic storms in the coastal areas and floods due to overflowing rivers. Certain parts of our vast coastline, especially Andhra Pradesh and Orissa coasts in the east and the Gujarat coast in the west, are particularly prone to onslaughts of cyclonic storms which originate and grow over the warm seas and strike the coast with violent fury. Often huge tidal waves hit the coast under the influence of these storms inundating vast areas. Also these storms bring in their wake heavy rains which often cause widespread flooding in the coastal areas.



A satelite imagery shouring the floods in the plains (above) and the normally flood-prone areas (left)

Floods due to cyclonic storms are purely a natural calamity. Man has no hand in it. Fortunately, as the storm develops over a period of days, there is in most cases ample time to take precautionary measures. Loss of life can be almost totally avoided by advance warning which is possible now with satellite based advance disaster warning systems.

In India, it is the floods in rivers caused by heavy rain in the catchment areas during the monsoon that pose the greatest threat. Although rains are a natural phenomenon, the floods and the damage they cause are often the result of man's folly. For one thing, the total amount of rainfall in the catchments has changed little in the past several decades though there may be variations in intensity from year to year. But the severity of flooding in the rivers has increased steadily over the years leading to greater losses. Much of this has been the result of man's overexploitation of nature. Indiscriminate deforestation, overgraz

Forecasting Floods

LOSSES due to floods, especially of human life and livestock, can be considerably reduced by flood forecasting and early warning to the affected areas. Usually a flood peak takes from a few hours to a few days to pass from a point upstream to a point downstream along a river. So, if the intensity of rain fall and the water level at various points are constantly monitored it is possible to issue forecasts of floods downstream well in advance for the local authorities to take precautionary steps to minimise losses, by moving people and livestock to safer places. In fact, compared to the other measures, flood forecasting and early warning offers one of the most cost-effective methods of flood management,

The Central Water Commission set up the first flood-forecasting station in India way back in 1959. Today, it has a network of 157 forecasting stations which issue on an average nearly 5500 flood forecasts every year, most of them during the monsoon months. The forecasts are issued daily throughout the six-month flood season — May to October — and also during the northeast monsoon season which often brings floods to the east coast from October to December.

Bihar has the largest number of forecasting stations, a total of 36, followed by 33 in Uttar Pradesh, 23 in Assam, 14 in West Bengal, 11 each in Orissa and Andhra Pradesh, 10 in Gujarat, 7 in Maharashtra, 4 in Karnataka, 3 in Madhya Pradesh, 2 each in Delhi and Dadra and Nagar Haveli, and one in Haryana.

Typically the forecast is prepared on the basis of the daily water level of a river or its tributary as observed at a specified time in the morning at all the monitoring stations and is transmitted to the CWC headquarters in New Delhi from where a computerised daily bulletin is then issued. The forecast is also made available in all districts through NICNET, the computer network of the National Informatics Centre.

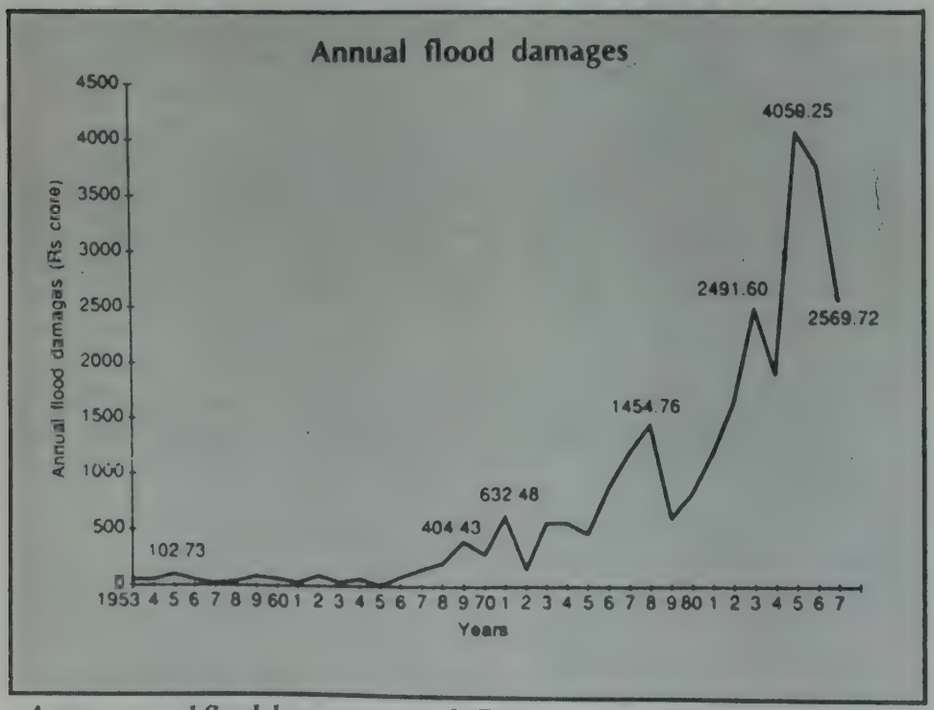
Today, thanks to the availability of satellites like IRS-1B and the INSATs, flood forecasting has become much easier than in the past. The Meteorological Department in coordination with Indian Space Research Organisation and the National Remote Sensing Agency can now keep a constant vigil over our river systems from space which has greatly improved the accuracy of flood forecasts. According to the CWC, during the 1992 flood season, its flood forecasting network achieved an all-time record with 96 per cent forecasts on target.

However, at present CWC's flood forecasting network does not cover many of the important flood-prone rivers and tributaries. The Eighth Plan document (1992-97) has emphasised the need for extending the forecasting network to other flood-prone rivers.

B.B.

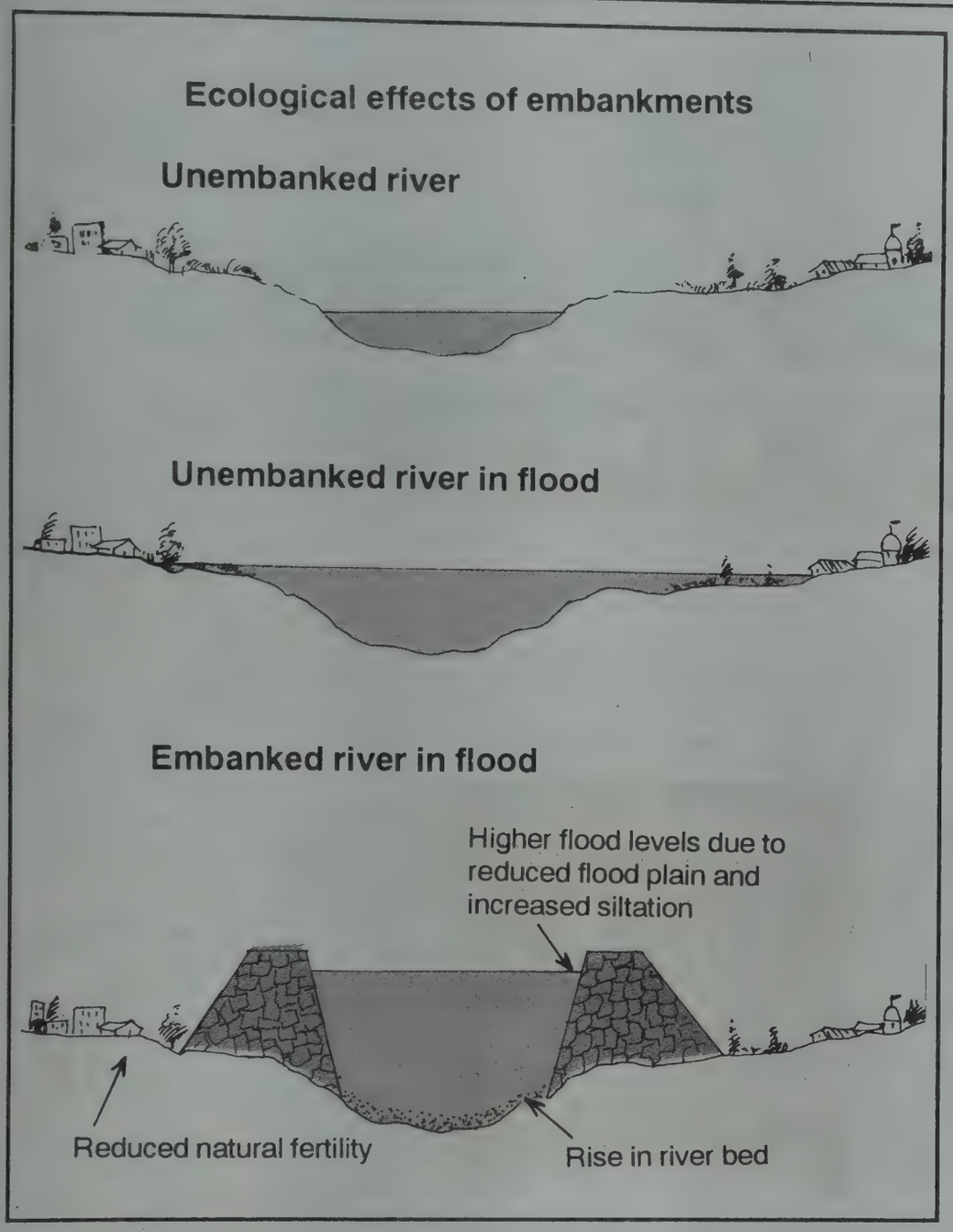
ing by cattle, wrong agricultural practices all have led to rapid soil erosion in the catchment areas which has resulted in greater silting in the lower reaches of the rivers. Once the river beds get silted up, their water carrying capacity gets reduced and any increased flow into them spills over the banks causing floods.

Flood control measures in India have been mainly confined to construction of storage reservoirs and drainage channels and raising of protective embankments along rivers. Several multipurpose hydel schemes have been constructed on major rivers not only to regulate their flow but also to generate power and irrigate agricultural land. Between 1954, when the National Flood Control Programme was launched, and 1987 more than 14,500 kilometres of embankments and more than 27,000 kilometres of drainage channel were constructed providing protection to more than 330 towns. More than 134 crore hectares of flood-prone area have been provided a 'reasonable level' of protection by these measures upto March this year.



Average annual flood damages were only Rs. 60 crore in the 1950s. They became a staggering Rs. 2,307 crore during the 1980s

Construction of dams and storage reservoirs is a reasonably successful method of reducing devastating floods. These reservoirs can hold the excess flow during peak seasons and release it later. But mere construction of dams and storage reservoirs is not


Ecological effects of embankments
Unembanked river
Unembanked river in flood
Embanked river in flood
Higher flood levels due to reduced flood plain and increased siltation
Reduced natural fertility
Rise in river bed

enough. An essential prerequisite for their successful operation is extensive soil conservation measures upstream of the river and around the reservoir. Unless soil erosion is prevented, especially in the catchment areas, reservoirs built at colossal costs easily get silted up and become useless. According to a survey of some of our major reservoirs published some years ago, the average annual rate of sedimentation in them is more than three times the estimated rate at the time they were built. This, in other words, means that the useful life of these reservoirs would be only one third or even less of their planned life. As heavy sedimentation cuts down a reservoir's capacity to hold water, it reduces its effectiveness in holding back heavy flood waters. Unless urgent steps are taken to check soil erosion, dams and storage reservoirs are meaningless as a flood control measure. However, if floods are caused by heavy rain downstream, dams and reservoirs cannot prevent them. In Punjab this year, for example, while the reservoirs of the Bhakra and Beas dams were far from full, torrential rains downstream were responsible for the devastating floods that affected nearly half the State's population.

The other major flood control measure that has been practised for years is the construction of embankments to keep the water from flowing into inhabited or cropped areas. Although embankments do provide some degree of protection, especially in populated towns and cities, basically they are an 'unnatural' way to check the river flow. Often, after construction of an embankment, the river actually flows 'above' the surrounding land areas protected by the embankments. In such areas if a breach occurs in the embankment, the consequences are often disastrous. The damage caused by a breached embankment is always greater because water gushing at high speed through a breach can cause far more damage than the slowly rising water in unprotected areas. Standing crops can withstand a metre or so of water if the level rises slowly. But even the strongest trees would snap like matchsticks in the face of a gushing torrent from a breached embankment.

Another problem with embankment is that, by preventing the silt carried by the river from spreading over extended areas on river banks they increase the silt deposition on the river-bed itself thereby raising its level and reducing its carrying capacity. In course of time, even moderately heavy rainfall in the catchment leads to flooding downstream. So, although embankments do play a protective role in some cases, the protection they provide is rather unstable.

Compared to the 'structural' measures like embankments, dams and drainage channels which rarely provide total protection against floods, 'non-structural' measures like flood plain zoning offer a more effective way of preventing losses due to floods. Flood plain zoning is one of the most scientifically sound and reliable method of flood protection. The concept is simple. One has only to keep in mind the fact that "where a river has the right of way, stay out of its way !" When a river flows over a flat terrain, like the Gangetic plain in India, it has a tendency to 'meander' or change its course frequently within a specific

(Continued on Page 58)

Cover Story

A RESOUNDING SUCCESS

Linking the vast countryside has been a goal difficult to achieve. The automatic exchanges developed by Indian telecom engineers offer a solution to this vexed problem, explains

PALLAVA BAGLA

SOMETIME in 1988 the small sleepy town of Kittur in Karnataka suddenly began bustling with hectic business activity. Bank balances began zooming up. The fleet of trucks owned by the local transporter were now on the road for seven days a week ! The jeweller was selling gold ornaments at prices prevailing in large metros like Delhi and Bombay. Behind the resounding success was a new telephone exchange that had started functioning in this small town. The 128 - line or port Rural Automatic Exchange (RAX) installed at Kittur was designed, fabricated and developed by the Centre for Development of Telematics (C-DoT).

Kittur is not the only example. As recently as the middle of 1992 a 256-line RAX had been installed at Anekal, a small town off Bangalore in Karnataka. Not much later the revenue earned by the Anekal unit of the Department of Telecom shot up seventeen times. The Department has already recovered the installation cost of the exchange! In addition the local residents are a happier lot, for, now in times of need they can talk to business associates and relatives all over the globe.

That the world has become a global village as a result of the information revolution is not an understatement. But, for a poor country like India to integrate so many far-flung villages into the existing telecom network is a task not easily achieved. Yes, imported technology was available. However, it was not only costly but rather unreliable too. Past experience has shown that when technology is imported the 'know-how' is usually given but the 'know-why' of trouble spots is not transferred and hence integrating it becomes a problem.

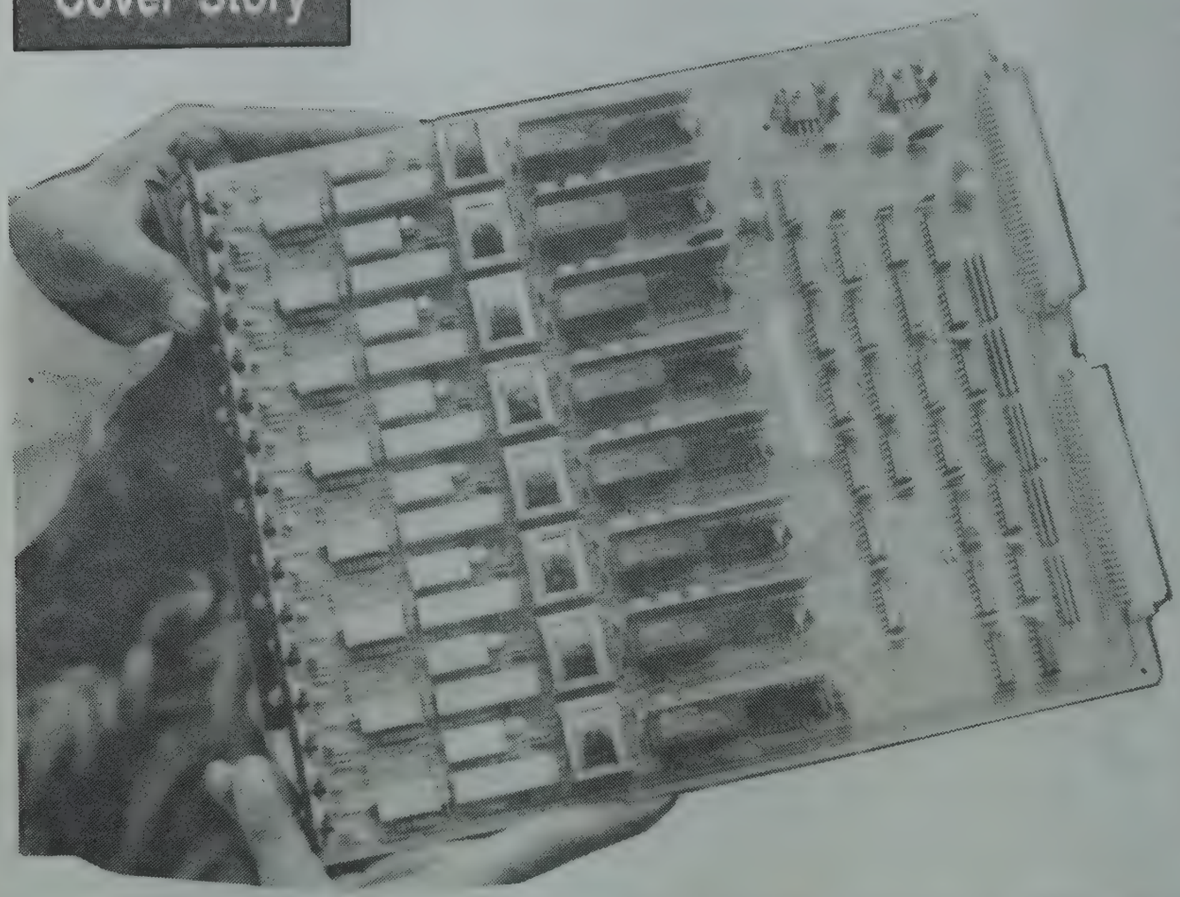
The imported machines needed luxurious air-conditioned comforts to deliver efficient service. A rather rare commodity called electric power was most essentially and reliably required to run these state-of-the-art telephone exchanges. Providing dependable power to far-flung villages is still an ideal yet to be achieved in our country. The overall consequence of all this was that Indian villages could not be accessed over the telecom network.

The need for integrating large portions of the country within the mainstream was immense, it was this background that led to the development of the RAX. The digital exchange developed by Indian telecom engineers is probably the best suited to our country. It does not require controlled temperature, dust free and low humidity atmosphere to work. Says K.N. Gupta, Director, C-DoT, "the components have been so chosen that they give the RAX an inbuilt strength to withstand any sort of climate and weather encountered in our country'. The rugged RAX has been functioning efficiently from the hot and dusty Thar desert of Rajasthan to the very wet and humid climate of the Khasi hills in Meghalaya. In terms of actual figures it means the system has been designed to work in an ambient temperature range of 0° to 45°C and a relative humidity range of 5% to 95%.

Today, over 8000 RAX exchanges are working all over India. Over one million telephone subscribers are using this indigenous technology to establish better contacts the world over.

Rigorous testing ensures high quality

"Developing a prototype exchange was not a difficult job ! It constituted only thirty percent of the efforts C-DoT put in. The bigger and more difficult job was to transfer the technology from the bench-top to the floor-shop in the factories", explained Gupta. He said that "for the first time

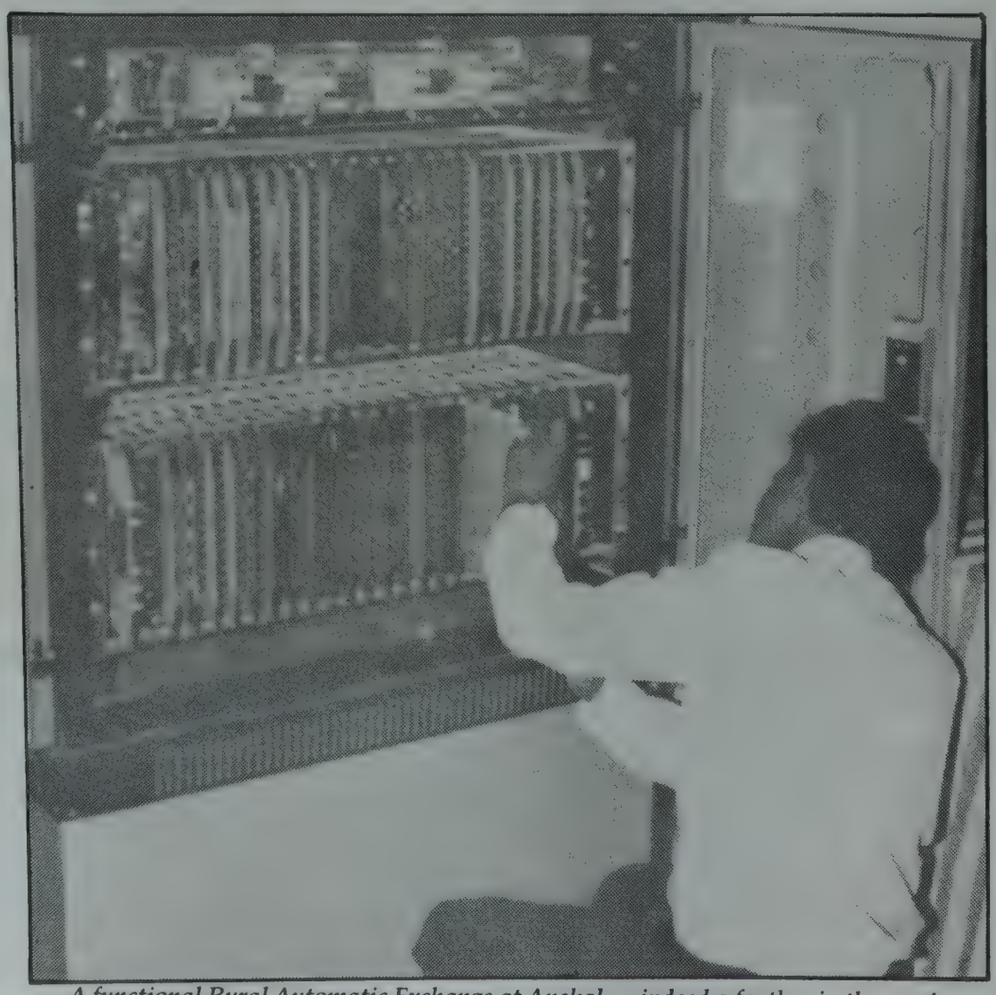


The printed circuit board (PCB) developed for the Rural Automatic Exchange

extensive links have been made with the Indian industry and today over forty licencees are using C-DoT technology to market very good quality machines both for use in India and abroad".

The heart of all telephone exchanges is what is called the switching system. In the older strowger and crossbar exchanges there were electromechanical parts which used to physically move to establish connectivity between two subscribers or telephone users. In the modern exchanges these are still called 'switching systems' but they lack components which move." 'The switching and routing of calls within the exchange has now become a function of the computer memory'' says Bishnu D. Pradhan, Executive Director of C-DoT. All operations in the RAX and other advanced models developed at C-DoT are computer controlled, requiring minimum human support. The computer program necessary to run the exchange — also called the systems software — is stored in the form of a 'read only memory' (ROM) and the 128-port RAX has an inbuilt software of about 64 kilobytes and the 256 RAX the double of this. The entire software development and debugging operations — removal of mistakes — were carried out inhouse by C-DoT software engineers.

The 128 and 256-port exchanges are the size of a small writing table. These exchanges are modular in approach, that is, two or more systems can be added together as the need for more phones arises. To provide almost trouble-



A functional Rural Automatic Exchange at Anekal — indeed a feather in the cap !

Missing Links

JULY, 1992. The name of my native town was heard in the national news on Doordarshan — for the first time. Instead of getting elated, the news made me rush to the nearest STD booth. A non-descript town resting in the folds of the western ghats in Mysore district some 2500 kilometres away from Delhi, Kollegal had erupted in one of the most violent riots. I was worried about the safety of my parents living there. It took me just sixty seconds — the time required to push a dozen buttons on the telephone — to contact home and put to rest my worries. The new electronic exchange at my native place put me through to my family instantly.

The situation was exactly the opposite some three years ago when the town had just a small manual exchange that took hours to get a line through. It is unbelievable now that such exchanges are still in vogue at places. In 1980, I worked as a telephone operator for some time in the Kollegal telephone exchange. It catered to just 300 subscribers. I still remember the three days during which the entire staff of telephone exchange tried their best to put through an urgent call demanded by a desperate subscriber. With the usual trunk routes to the steel town of Salem, some 500 km away being down, we had to probe other routes, call up all nearby exchanges for help. But, all in vain! The subscriber had to finally cancel the call after three days of waiting. Such failures were frequent.

Night-shifts in that exchange was an experience indeed. There would be a single operator, and a line-man, on duty throughout the night. The line-man would usually retire to the recreation room at the back of the old building and sleep. The operator had no such luck. Blaring alarms set-up by a calling subscriber or a distant exchange would disturb frequently. It was, in fact, near impossible to sleep as the relays in the exchange groaned and creaked in the eerie silence of the night.

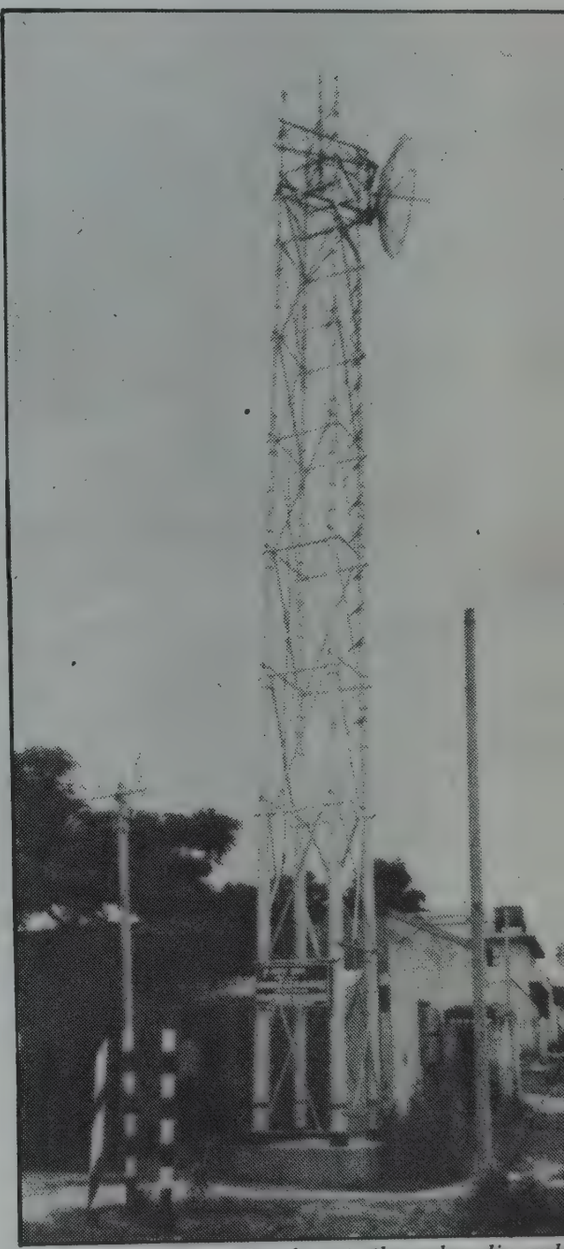
Working in such an exchange took a great toll of our energy. We often had to shout at the top of our voice into the microphone to make ourselves heard at a distant exchange. I often shouted in my sleep, too, scaring my family members. Today some of my erstwhile colleagues who are still at Kollegal, work in a relaxed manner. No more shouting, they can even whisper messages to Delhi. Subscribers don't rush to the exchange to complain, they all have STD facility. The only time operators are worried are the occasions when they have to put through calls to villages some 50-60 km away. These still have to be reached via a manual exchange and it takes many hours to effect a call. But reaching Delhi or Darjeeling in the foot-hills of Himalayas is pretty easy. A sea-change indeed!

Kollegala Sharma

free service there is a total redundancy of systems in the exchange. Each component has a functional duplicate available for immediate takeover in case the master unit fails. Moreover all circuitry is in the form of printed circuit boards (PCB's) ensuring very fast rectification of exchage faults. The damaged PCB can just be pulled out and immediately replaced by a functional PCB. In addition to this there is a built-in maintenance and diagnostic panel in the exchange to quickly identify the damaged card.

The problem of erratic power supply to these out of the way small towns does not pose a problem for the RAX because it can run for many hours on battery power. Now, some exchanges are being designed to run even on solar power. "The computer chips (metal-oxide semiconductor type) and microprocessors were so chosen that they not only consume low power but also do not generate much heat when switched on and off," says Gupta. This not only helps these exchanges to work in places not having dependable power supply, but as the heat generated is small it also makes the RAX work very well using only an air-cooled cooling system. The false panels at the bottom have ventilation slots to assist cooling by natural convection. The vents are so designed that rodents cannot enter the cabinet and damage the circuitry.

(Continued on Page 36)



Connecting village Panchayats through radio and microwave links

FLY-BY-WIRE AIRCRAFTS

The state-of-the-art aviation technology is not only fuel saving but also safe, says

BIMAL K. SRIVASTAVA

FEBRUARY 14, 1990. An Indian Airlines aircraft trying to land in Bangalore crashed to the ground killing 92 of its 146 occupants. The news made headlines not just because of the tragedy involved but also the nature of the crashed aircraft. The aircraft was a freshly acquired A-320 plane, acclaimed as a wonder-kid of the latest technology. The crash resulted in the suspension of flights of all such Indian Airlines aircrafts for nearly one and a half years. With this controversy the A-320 aircraft and fly-by-wire technology became household terms.

"Fly-by-Wire (FBW)" is a common term frequently used for an Airbus-320 aircraft (A-320). It has almost come to stand for the A-320 aircraft. As a matter of fact the term "Fly by Wire" is used more in its

literal sense — flight by the help of wires. In other words FBW is a technology in which all the flight controls of the aircraft are operated electrically or electronically by computers and not by conventional mechanical controls. Under FBW technology, the pilot controls the aeroplane by means of computers, which is considered extremely reliable, accurate, faultless, powerful and independent of human errors.

DURING early days, pilots relied entirely on mechanical systems for controlling the flight. For instance, if the pilot wanted to climb, he moved a joy stick in the cockpit. The joy stick was connected to the 'elevator' of the aeroplane located at the tail end through a metal wire. When the joy stick moved, it pulled the wire, which in turn lifted the elevators, causing the aeroplane to climb. Similarly, for other flight controls also, such as banking to the left or right, the pilot had to move wires or chains connected to ailerons (located on the wings) by the help of joy stick. In later age aeroplanes, however, the joy stick was replaced by a control wheel which was more like steering a motor car, but the chains and wires remained. Similarly for giving a yawing movement to the aeroplane (or for turning), pilots had to press on the rudder pedals, which operated the rudders located at the tail. Thus there used to be a number of metal wires, pulleys, and chains passing from cockpit to the wings and to the tail portion. This is still the state-of-affairs in small flying-club aircrafts. The mechanical control operations were to the aircrafts what the rods and levers connected to the steering wheels were to an automobile. For example, if the car driver turns the steering, the wheels are turned by means of iron rods or axles. Similarly for changing gears or applying hand-brakes or clutch rods and levers are used.

Gradually the aeroplanes acquired improved systems like hydraulic, pneumatic and electrical. Controlling the new generation giant aeroplanes like Boeing 747 (or Jumbo jet), Airbus (A-300), DC-10 and so on became easier with these systems. In a way it was inevitable too. For, the huge control surfaces such as elevators, ailerons, rudders, flaps of these aeroplanes are so heavy that it is humanly impossible to raise or move them through mechanical means. That is why additional systems were needed to complement the conventional mechanical system for operating the flight controls of such huge aeroplanes. Most of these aeroplanes, infact, are equipped not with a single system but with multiple systems for operation of any particular control. For example, for extending the huge landing gears of a B-747 aircraft (the Jumbo-jet), hydraulic system is primarily used. However, in case of failure of the hydraulic system, these landing gears can be extended by mechanical means. So much so that in extreme case of failure of both hydraulic and mechanical systems, it can even be operated by manually or by the help of earth's gravitational force. Similarly, the brakes of a Boeing 707 aircraft, normally operated electrically can however be operated manually in case of failure of the electrical system.

Under 'fly by wire' technology, electrical, electronic and computer systems fully replace the conventional mechanical system. However, they only partially replace hydraulic or pneumatic system.

THERE are innumerable advantages of FBW technology. The first and foremost is the reduction in the weight of the aircraft. The conventional aeroplane using plenty of me-

Turbulent Take off

THE FBW technology based A-320 aircraft did not have smooth sailing right from its inception. The first setback encountered by A-320 was on 25 June 1988 when during its maiden demonstration flight in France, the aircraft crashed. This was the occasion when thousands of people had assembled to witness the airshow at a place called Mulhouse in France. The moment this aircraft took off from the runway it fell down and was destroyed due to impact and fire.

Another jolt to the reputation of this aircraft was the accident near Bangalore. Doubts were raised whether it was safe enough to fly an aircraft purely on the basis of computers and machines ? It was also questioned whether the accidents were caused due to automation, and, further, under such odd situations why the computers installed in the aircraft did not come to the rescue ?

Manufacturers maintained that the main cause for such problems was the initial hurdles experienced during a sudden changeover from a manual to a completely computer controlled mode. The pilots were taking some time to get used to this changeover. They stated that these were teething problems and once the new technology is adapted fully, the problems would automatically disappear.

It seems that the claim of Airbus Industrie — the manufacturers of A-320 aircarfts — is coming true and A-320 has slowly started developing confident sales appeal among aircraft users and pilots. In fact more than 240 aircrafts were sold till the end of 1991 to various airlines all over the world. Judging by the number of purchase orders received, A-320 seems to have turned into one of the fastest selling aircrafts. So much so, even other manufacturers have started introducing computer technology in their new version aircrafts. However, we may have to wait and see till a clear picture emerges to prove the claims of computer technology over the conventional technology in the field of aviation.

B.K.S.

chanical wires pulleys, levers, chains, rods, tubings and other metallic objects is pretty heavier than an FBW plane. This is because the FBW system uses thin and light-weight electrical wires, subsequently reducing the overall weight of the aeroplane. Thus not only can the fuel be saved, but more number of passengers can be accommodated in each flight.

Further, in a conventional hydraulic or pneumatic system, liquid or air under heavy pressure is used. As a matter of fact, a special liquid known as 'skydrol' is used at a pressure of 3000 psi (which is some 200 times more than the atmospheric pressure) in the hydraulic systems. Due to such high pressure there is a possibility of loss of all the liquid if there occurs a small cut or a crack in the tubing. Such instances of hydraulic fluid loss are quite common. With the use of electrical wires such problems can, however, be avoided.

The greatest advantage of equipping an aircraft with FBW technology is that all the calculations related to flight are made by the computer itself. Suitable instructions based on the calculations are also issued by the computer making it possible for the flight to be conducted in a safe and fuel-saving manner. For example the computer operated Electronic Centralised Aircraft-Monitoring (ECAM) system of A-320 aircrafts conducts more than 50,000 calculations every second, something impossible for even the best of human minds. It also issues suitable

The cock-pit of a conventional air-craft crowded with panels

The less crowded cock-pit of an FBW aircraft gives a clear view of things ahead

instructions to update and correct the height, speed and altitude of the aircraft so as to get the best mileage out of the fuel.

Further, if by any chance, any of the instrument or a part of the aircraft fails or malfunctions, the computer issuing warning signals in the cockpit alerts the crew to take corrective action. As a matter of fact these computers even display the relevant procedure required to be followed in case of such failures. Thus the pilot can avoid the cumbersome procedure of referring to bulky manuals since he is able to view the same manual over a screen. These manuals like the 'Flight Manual', 'Aircraft Operations Manual' and many other such documents are considered a part and parcel of the aircraft and it is mandatory to carry them on board the aircraft. No wonder a computer does a great service in replacing them and at the same time carrying all the information in the bulky manuals.

A-320, which is based on FBW technology has another first to its credit. With-fly-by wire system, the conventional control wheel or control column in the cockpit has been replaced by a small side-stick controller giving the pilot an unobstructed view of the instrument panel. The side-stick controller is more like an electrical switch, and has enabled manufacturers to reduce the weight of the aeroplane substantially.

The cockpit of FBW aircraft is normally termed as "clean cockpit" (or sometimes a "Glass Cockpit"). The reason is that the numerous instruments and dials seen in the cockpit of a conventional aircraft are absent here. The cockpit of a A-320 aircraft has only six sets of Cathode Ray Tubes (computer monitor screens) on which all the instruments and their readings are clearly displayed. The incorporation of entire primary data on the Electronic Centralized Aircraft Monitor (ECAM) display has further reduced the cluttering of instruments in the cockpit.

It is not that the computers can't fail. They can also falter and FBW technology takes into account this aspect also. In FBW technology, more than one electronic systems are available for any control. For example, in A-320 aircrafts there are four systems used so that the operation and navigation of the aircraft is possible even in difficult situations.

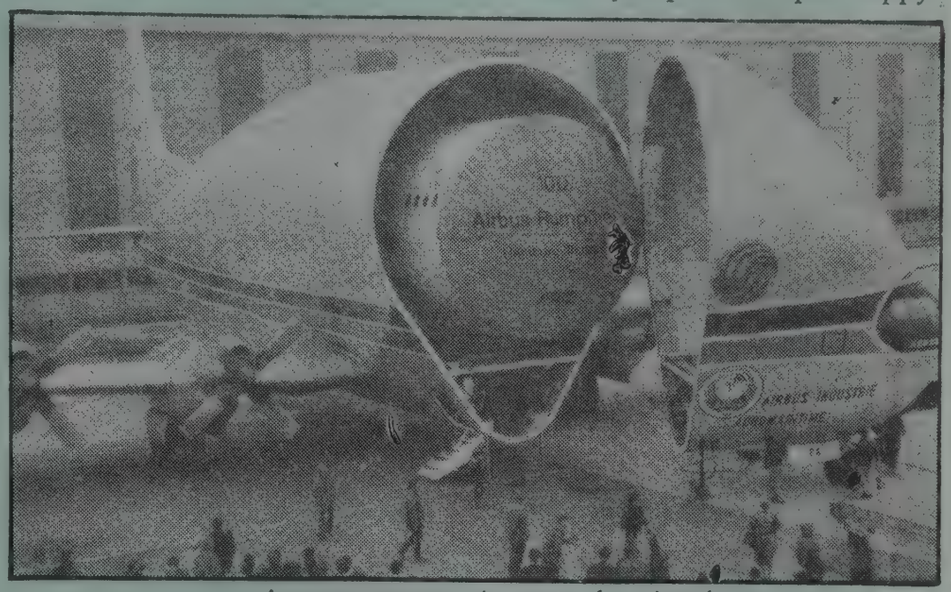
However the best feature in a FBW aircraft is that, if by any chance the pilot makes a mistake during flight, the computers correct him by issuing suitable warnings or prevent mistakes by locking the relevant control at the safety limit.

As a matter of fact with its computer screens, absence of control columns (in other words with its space-age cockpit environment), the FBW aircraft can be dubbed as a push button aircraft, and the A-320 is a fine example.

The A-320

THE main feature of the A-320 aircraft is that various parts of this aircraft are manufactured by different companies located in different countries. For example the rear main fuselage is manufactured in Germany; wings in U.K.; tail portion in Spain; main body, the fuselage and cockpit in France, and wing *slats* in Belgium. Finally all the parts of the aircraft are assembled in France to give the final shape to the A-320. Because of this the manufacture has to be very precise, to the last nut and bolt. Otherwise the parts may not fit together or may start malfunctioning. However the manufacturers construct these parts with such an expertise that they can be assembled in an absolutely faultless manner.

Another important aspect of this manufacture is the transportation of various parts of the aircraft to the assembling place — a feat indeed. The huge parts of A-320 manufactured at different places are brought to the central assembly place in France by a special "Super Guppy" aircraft. This aircraft has a huge belly which splits open in two parts to accommodate large and heavy parts of A-320. The "Super Guppy" shuttles from country to country bringing these parts to France.



A super-guppy carrying parts of an aircraft

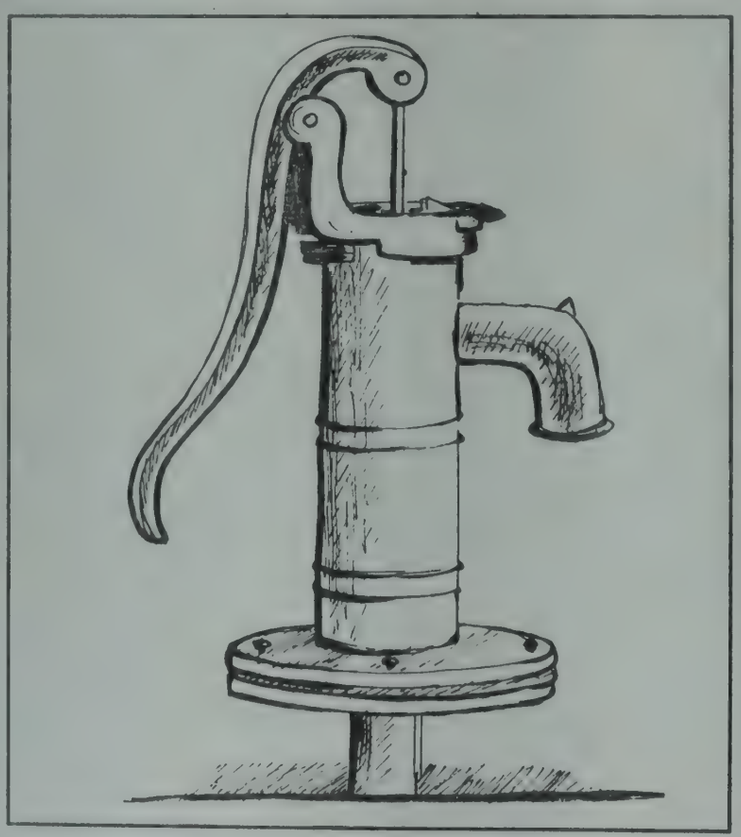
B.K.S.

Shri Srivastava is Deputy Director (Cartography), National Airports Authority, Safdarjang Airport, New Delhi-110 003

WATER UNDERGROUND

There are definite ways of locating the precious water underground, say *N.P. SRIKANTHA* and *T.R. ANANTHARAMU*

THE peak summer of 1986 in Meghalaya had an unusual warm message for the civilians of Mausinram, a place which receives more rains than Cherrapunji. Cherrapunji is famous for receiving the highest rainfall in the world. But, surprisingly, the notice board in the Public Works Department office in Mausinram asked the civilians to cut down their groundwater consumption, as the local water table had gone down during that year. For meteorologists, Cherrapunji and Mausinram make little difference, as they are the first to receive the south western monsoon and are located in the same belt on an elevated plateau. Cherrapunji, the abode of rainy clouds, has two records to its credit : the downpour in July 1961 that drenched the surface and measured 9299 mm and again in the same year another record was created when 26461 mm of rain fell there. This record canonly be improved either by Cherrapunji or Mausinram. Though the monsoon plays hide and seek in the rest of the country, the Cherrapunji belt always gets its share of an average annual rainfall of 10,000 mm. Isn't it a paradox! This cry for drinking water is a serious problem in a place where there is highest rainfall. Cherrapunji is aptly, but awefully, described as the 'wet desert'. The reason for Cherrapunji's sad state is in the features of the ground there.



Cherrapunji has many geological and geomorphological factors which are not congenial for retention of rain water. In the first place, the area is blanketed by a thick column of limestone which lacks the pores necessary for downward filtration of surface water. On the other hand, the interconnected subsurface drainage in the limestone and the location of Cherrapunji on the tip of the plateau with its steep gradient arrest the percolation of rain water and leads to heavy run-off.

Cherrapunji is only an example of the case where there are opposing factors. In our country, there are many such unfavourable conditions where, though there is copious rainfall, the subsurface is devoid of potential groundwater reservoirs.

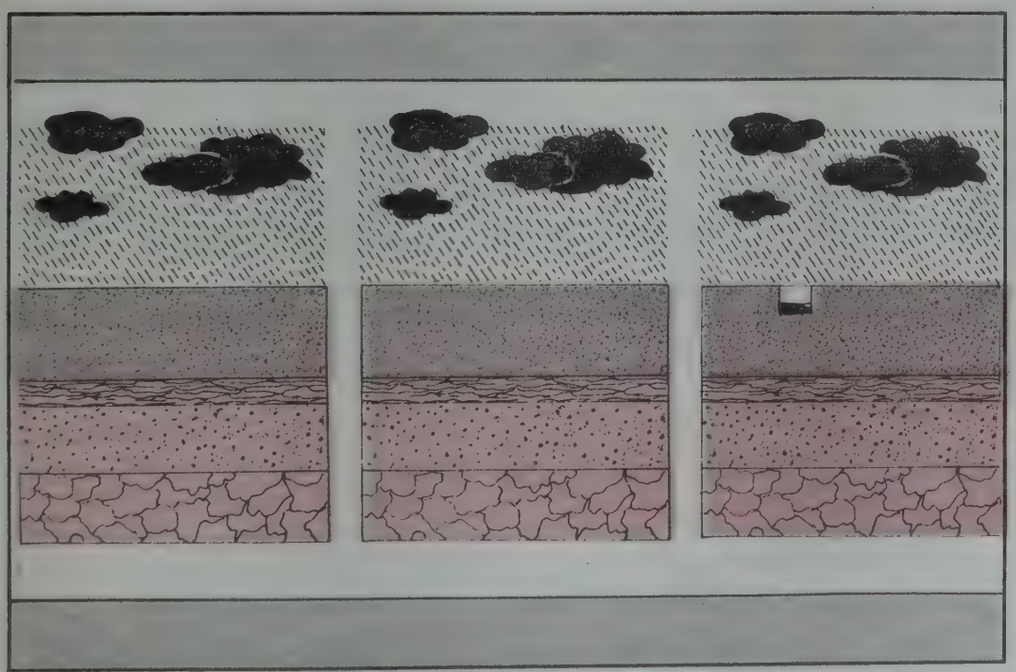
It is desired that the rock formations should not only be porous but permeable too for the formation of groundwater reservoir. Permeability is the capacity of the rock to transmit water. There are soils and rocks which are porous but not permeable, for example, clay.

Groundwater reservoir largely depends on the rain water. Groundwater itself is an important component of the hydrological cycle. It is estimated that out of 370 million hectare metres (one million hectare metre will fill one

million hectare to one metre depth) of rainfall received in India, 170 m.h.m. flows through the river, 120 m.h.m. is lost by evaporation, and 80 m.h.m. enters the soil as seepage. Out of the 80 m.h.m. seepage, almost half the volume is held by the soil as moisture and the other half percolates deep down in the rock. Out of this percolated water about 26.3 m.h.m. only becomes available for groundwater replenishment. In other words a mere 72 % of the annual rainfall replenish the groundwater.

India's varied topography, as varied as its diverse culture, and a multitude of geological formations,. both play a vital role in the development of its groundwater reservoirs. Consolidated crystalline rocks, sedimentary rocks and unconsolidated sediments are present in different regions of the country. While the southern peninsula is covered by 131,000 hectares of hard rocks, the Indo-Gangetic plains have alluvium which is a rich source of groundwater. In the peninsular India, bore-wells have to be dug to at least 30 metres depth to get to some water, whereas in the gangetic plains it needs just a few metres.

People living in the hilly areas commonly meet their water requirements from springs running along the slope of the hills. Springs are also the surface manifestations of groundwater. Wherever the water-table intersects the ground surface at the edges of slopes water flows in the form of springs. The term 'water table' denotes the surface defined by the water level in the well. To be more specific it is the surface underground along which the hydrostatic or water-pressure equals the atmospheric pressure. The only prerequisite for a spring is the infiltration of rain water in a porous rock underlined by impervious rock. Hydrogeologists differentiate the sub-surface water as confined and unconfined water. If water is in direct contact vertically with the atmosphere in an open space or through a permeable material, it is unconfined water. On the other hand, confined water is separated from the atmosphere by impermeable material, may be hard rocks lying metres below the ground. It is this confined water held under great pressure that produces the flowing wells, popularly known as 'Artesian' wells. Such wells can exist in any geological formation, though they are abundant in sedimentary terrains. In the West Godavari district of Andhra Pradesh there are Artesian wells yielding upto 52,000 gallons per hour, with a water level of 8 m rising above the ground level. Such structures are great assets, specially, for irrigation purposes. Springs or wells get their source from the rain water through infiltration which contributes to the groundwater. Groundwater is not static. Depending on the permeability of the rocks and the difference in vertical elevation groundwater moves with varying speed, under the force of gravity. The movement of groundwater is very slow, hardly 15 cm a day. The movement of groundwater can be traced by introducing dyes into dried up wells taken as recharge points and picking them up from other nearby wells.



Rain water gradually seeps through permeable soil layers finally saturating it. This gives rise to the watertable

Groundwater as a source of drinking water needs no introduction. The use of groundwater for agriculture and drinking purposes has a long history. In the Harappan civilisation dating back to 3000 B.C., open wells were dug for drinking water. The ancient Chinese had developed crude drilling methods for construction of tube-wells. In the absence of reservoirs and irrigation canals groundwater remains the only alternative source of drinking water for people living in places remote from rivers and other water bodies. No wonder, finding the whereabouts of this fluid under the ground is so important.

Locating of ground water, of late has a multidisciplinary approach right from using surface instruments to the remote sensing techniques. The physical properties of sub-surface rocks come to good use in locating the groundwater. In retaining the groundwater, the sub-surface structures, the nature of rocks and of course infiltrations are the deciding factors. For instance, the resistivity of natural

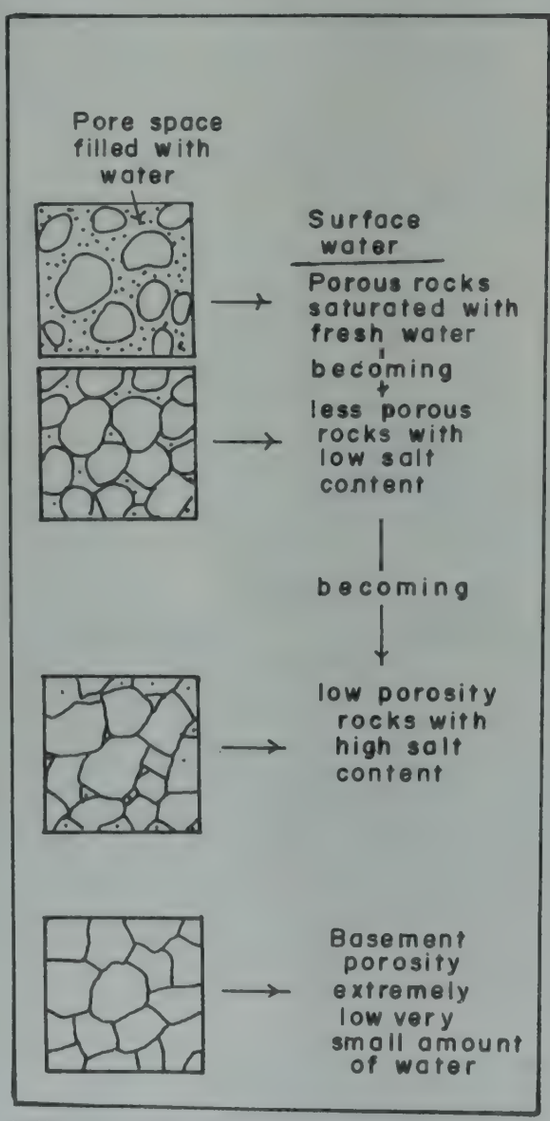
DOWSING : SCIENCE OR HOAX ?

INDIA, being an agricultural country, the demand of water for irrigation is growing unabated. Drinking water demand likewise has grown with the growth of population both in rural and urban sectors. It is but natural that a great emphasis is laid for groundwater exploitation. There are many central and state agencies which are carrying the specialised task of locating groundwater in different basins of the country. But, nevertheless, people who claim that they have magical powers of locating groundwater are increasingly in demand. Such people called dowsers *(paniwallas)* use forked sticks or rods and straightaway walk on the fields exhibiting a variety of mannerisms. Some dowsers shiver while others bend the forked twig indicating the points of groundwater.

Dowsing is no new practice, in fact, a treatise on dowsing is available in French which is as early as 1693. Though systematically such *paniwallas* cannot explain the scientific background they do admit involuntary muscle contractions. Should this be mistaken for magical power ? They are also unable to explain whether they are able to sense the change in the temperature in the sub-surface or whether they are sensitive to electro magnetic variations. Still the farmers and in some cases even the educated people prefer *paniwallas* for the simple reason, that it works out to be cheaper. Though water is present in the sub-surface in varying amounts no extra magic by dowsers can bring water in the consolidated hard rocks. In many a case, the dowsers are unable to give the exact quantity of water present beneath. It can only be said that the innocence of the people is exploited by dowsers. Their apparant success gets wide publicity while their failures are only lamented.

N.P.S. & T.R.A

materials like rocks to the flow of electricity varies widely. This has been made use of in the electrical method of locating the water bearing strata. In fact, it is the most common method of locating the underground water sources from above the ground without digging up any earth. Each geological formation has a different resistivity. For instance, fresh granites which are yet to decompose show a resistance of more than 2000 ohms per metre while the weathered product of the same rock shows as low as 150 to 200 ohms per metre. In the electrical method, both natural and induced electric potential are measured. For this electrodes are arranged by spacing them at different distances. Lower the resistance higher the chances of locating water bearing formations. For instance, water bearing clay formations in the sub-surfaces record very low resistivity. This knowledge can be used successfully in locating the boundary between salt water and fresh water. The alluvium-bed rock contact in river valleys and also water bearing gravel bed below the clay layers are also located thus.


Pore space filled with water
Surface water
Porous rocks saturated with fresh water
becoming
less porous rocks with low salt content
becoming
low porosity rocks with high salt content
Basement porosity extremely low very small amount of water

Different kinds of soil have different water-holding ability

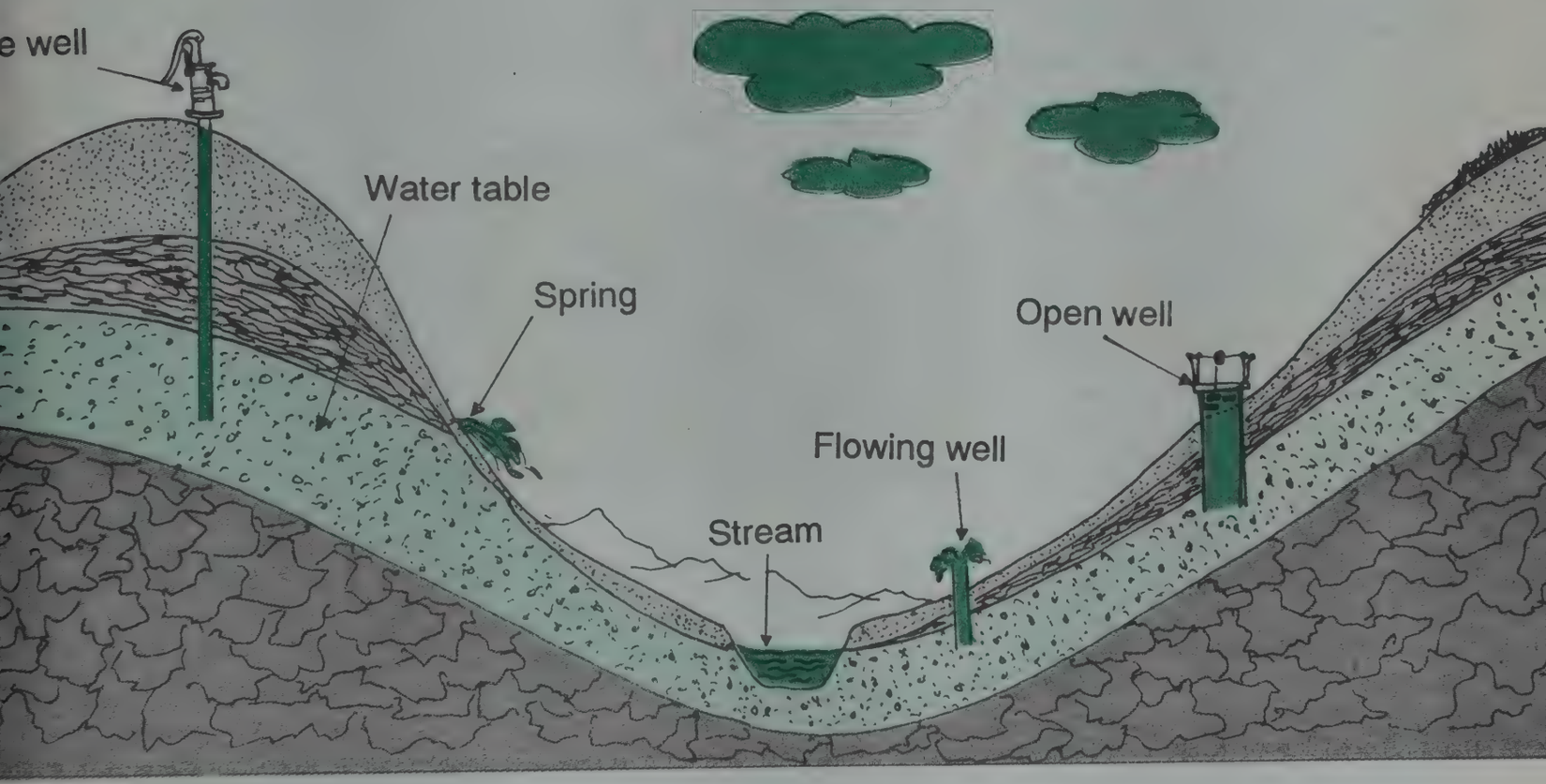
Seismic method is the other widely employed method of locating underground water. In this method the reaction of geological formations to the shock vibrations produced by a deliberate explosion are measured. Here, detectors called geophones are placed on the ground at various distances to pick up the vibrations which are then recorded on magnetic tapes. Geophones are spread out either in a fan-like pattern or arranged in a single straight line from the point of explosion. The basic principle underlying this method is that the speed of vibrations which pass through different types of rocks varies. For instance, waves move rather slowly in coarse gravel while solid granitic mass transmit the waves much faster. By this method, even the direction of buried channels can be located as indicated by the direction of the slow travel of the shock waves.

The latest entrant to the club of techniques of locating sub-surface water sources is the remote-sensing technique. Remote sensing by artificial satellites has contributed as much to hydrogeology as to soil

science and forestry. The images obtained by Indian Remote Sensing Satellites have proved invaluable for the management of national natural resources including underground water. Especially, the imagery of IRS-1A (launched in 1988) has provided important information on various hydrogeomorphological units like structural lineament, fracture, faults in the underground rock formations which are also usually the zones where groundwater can be found. By careful study of such imagery, the alluvial fans or buried channels can be located. The remote sensing data from satellite provide quick information on the factors controlling the occurrence and movement of groundwater. Maps prepared on this line for the entire country are now available and have proved to be great assets in finding the essential liquid for life in remote, thickly forested north eastern regions and the deserts of Rajasthan.

No doubt, groundwater has many advantages over surface water, most important of which is the limited loss due to evaporation. The gravity of water loss is severe in arid areas, where the surface water losses some time account for more than 350 cm a year. That is a colossal loss of nearly 5 million gallons of water from 1.6 sq km area every day! Though groundwater is a renewable resource by replenishment, its over-exploitation specially by industries has posed a greater problem — the threat of its depletion. Groundwater is a rare commodity and all care should be exercised for conserving it and its exploitation should never overtake its recharge by rain water.

To discover the water bearing strata, the Central Ground Water Board in association with state geological agencies is engaged in the analysis of the scientific data right from the run-off, precipitation, recharge and discharge calculations all over the country. Therefore, it is also the responsibility of the scientists to educate the rural mass against the exploitation by *paniwallas* who claim that they are blessed with magical power — a great hoax!



The underground water is tapped from above the ground using different means. Springs and artesian wells naturally bring water in the water-table above the ground. Borewells and openwells are the efforts of man to reach the underground water

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DEBENDRA MOHAN BOSE

A Silent Scientist

HASAN JAWAID KHAN

A man of few words, unassuming, a silent worker and a strikingly handsome figure is how people who knew Debendra Mohan Bose describe him. Yet today very few even know about, let alone remember, the man who was honoured in India and recognised abroad for pioneering researches in the field of cosmic rays, artificial radioactivity and neutron physics. He built the first indigenous cloud chamber to track ionizing radiations way back in the 1920s. He is also remembered as the scientist who more than once came close to making major breakthroughs which later won the Nobel Prize.

If one were to talk about formative influences on young Debendra there would be no dearth of it. He had illustrious peers all around him. Debendra was born in Calcutta on 26 November 1885. His father, Mohini Mohan Bose, who was a practising Homeopathic physician was among the first Indians to have visited the United States of America. His uncle, Ananda Mohan Bose, was the first Indian Wrangler in Mathematical Tripos from Cambridge. Later he was elevated to the Presidentship of the Indian National Congress in 1898.

Debendra Mohan's mother was Subarnaprabha Bose, younger sister of Sir Jagadis Chandra Bose, the renowned physicist and plant physiologist. J.C. Bose lived in the same house with Debendra's family at 64/1, Mechuabazar Street. For some time P.C. Ray, the famous chemist and a close friend of J.C. Bose too stayed in the same house on his return from Edinburgh. Apart from the company of the two illustrious men young Debendra had great fun here. Being situated in a low-lying area the place got flooded everytime there was a heavy shower. Debendra and his companions would then make rafts, borrow boats and indulge in a lot of fun and frolic.

In 1901 the family shifted to 92/3, Upper Circular Road. P.C. Ray who had by then shifted to 91, Upper Circular Road founded the Bengal Chemical and Pharmaceutical Works. Young Debendra had the good fortune of interacting with people like Nil Ratan Sircar, Rabindranath Tagore, Loken Palit, Sarala Debi and Charuchandra Dutta and Sister Nivedita all of whom were regular visitors to P.C. Ray's house. Debendra Mohan was also inspired by the renowned Swedish scholar M. Hammergren who had come to gather material about Raja Rammohun Roy and the Brahmo Samaj.

Serious business apart young Debendra was a versatile sportsman too. He was one of the founders of the Sporting Union Club and the captain of the club's hockey team in 1905-06. While a student of the Presidency College he excelled in cycling, football and cricket.

Debendra Mohan's uncle J.C. Bose had by far the most formidable influence in shaping his life and career. It had been tacitly assumed during his boyhood that Debendra Mohan would undergo training in science to enable him to carry on his uncle's pioneering researches. But fate intervened. Debendra's father died in 1901. Now it became necessary for him to take up a profession to support his family. After he passed his F.A. examination from Presidency College in 1902 J.C. Bose suggested that Debendra Mohan join the Bengal Engineering college at Sibpur. But after one year of study there he went down with a severe attack of fever and abandoned the idea of returning to the malaria-infested place again.

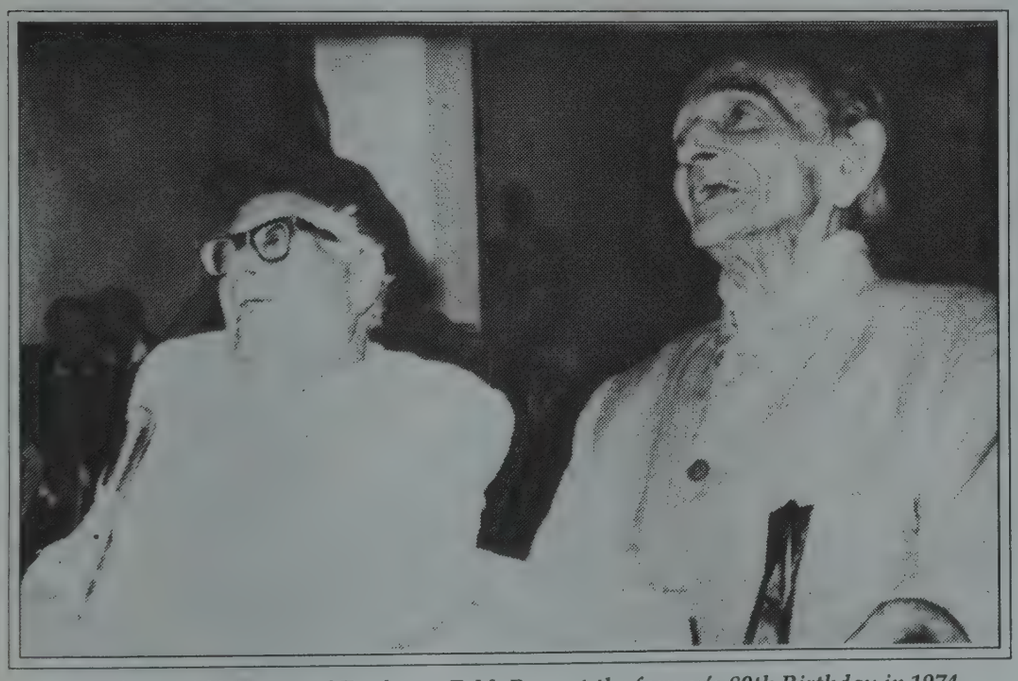
With the aim of moving on to the engineering college in Poona, Debendra got himself admitted to the third year B.Sc. class of Presidency College in 1903 with Physics as his main and Geology as one of his subsidiary subjects. He passed the B.Sc. examination with honours in 1905 and the M.A. examination in Physics in 1906 standing first in Calcutta University. For a year thereafter he worked as a research scholar under J.C. Bose and obtained his initiation into his uncle's investigations in plant physiology.

The very next year in 1907 Bose got an opportunity to go to England where he was admitted as an advanced student course in Christ's College, Cambridge. He worked in the Cavendish Laboratory for some time under the guidance of Sir J.J. Thomson. Here he had the opportunity of observing C.T.R. Wilson develop his technique of employing the cloud chamber for photographing the tracks of ionizing particles. In 1910, he joined the Royal College of Science, London from where he obtained in 1912 the A.R.C.S. diploma as well as B.Sc. in physics with a first class.

On his return to Calcutta in 1913 he joined as Professor of Physics in the City College. Soon thereafter, in April 1914, he was appointed Rash Behari Ghosh Professor of Physics at the Calcutta University. The physicist C.V. Raman was a Palit Professor in the same department. Besides, there were a number of brilliant lecturers like P.N. Ghosh, Satyendranath Bose, Meghnad Saha and S.K. Mitra. Soon after Debendra Mohan was awarded the Ghosh Travelling Fellowship for two year's advanced study in Physics. He worked with Professor E. Regener at the Berlin University.

Unfortunately, the first World War broke out and Bose got trapped in Germany for quite sometime. However, he was allowed to continue his studies under Professor Regener who assigned him the task of constructing a new cloud chamber. His training under C.T.R. Wilson proved useful. He managed to design a modified Wilson-type cloud chamber to photograph the tracks of recoil protons produced during the passage of fast alpha particles through a hydrogen-filled chamber. However, he was not permitted to present his Ph.D. thesis until the War ended.

During his stay in Germany Bose had the rare opportunity of attending the lectures of Max Planck, Albert Einstein, Rubens, Warburg, Hertz, Max Born and others. Bose obtained his Ph.D. (*magna cum laude*) degree from the Berlin University in March 1919 and returned to Calcutta to resume his Ghosh chair at the Calcutta University which he held till 1935. In 1935, C.V. Raman left for Bangalore as Director of the Indian Institute of Science. D.M. Bose succeeded him as Palit Professor of Physics. After a couple of years, after the death of Sir J.C. Bose, he took over the mantle of Bose Institute as Director in 1938. He served the Institute with rare distinction for almost thirty years and retired in 1967 when his health began to fail.



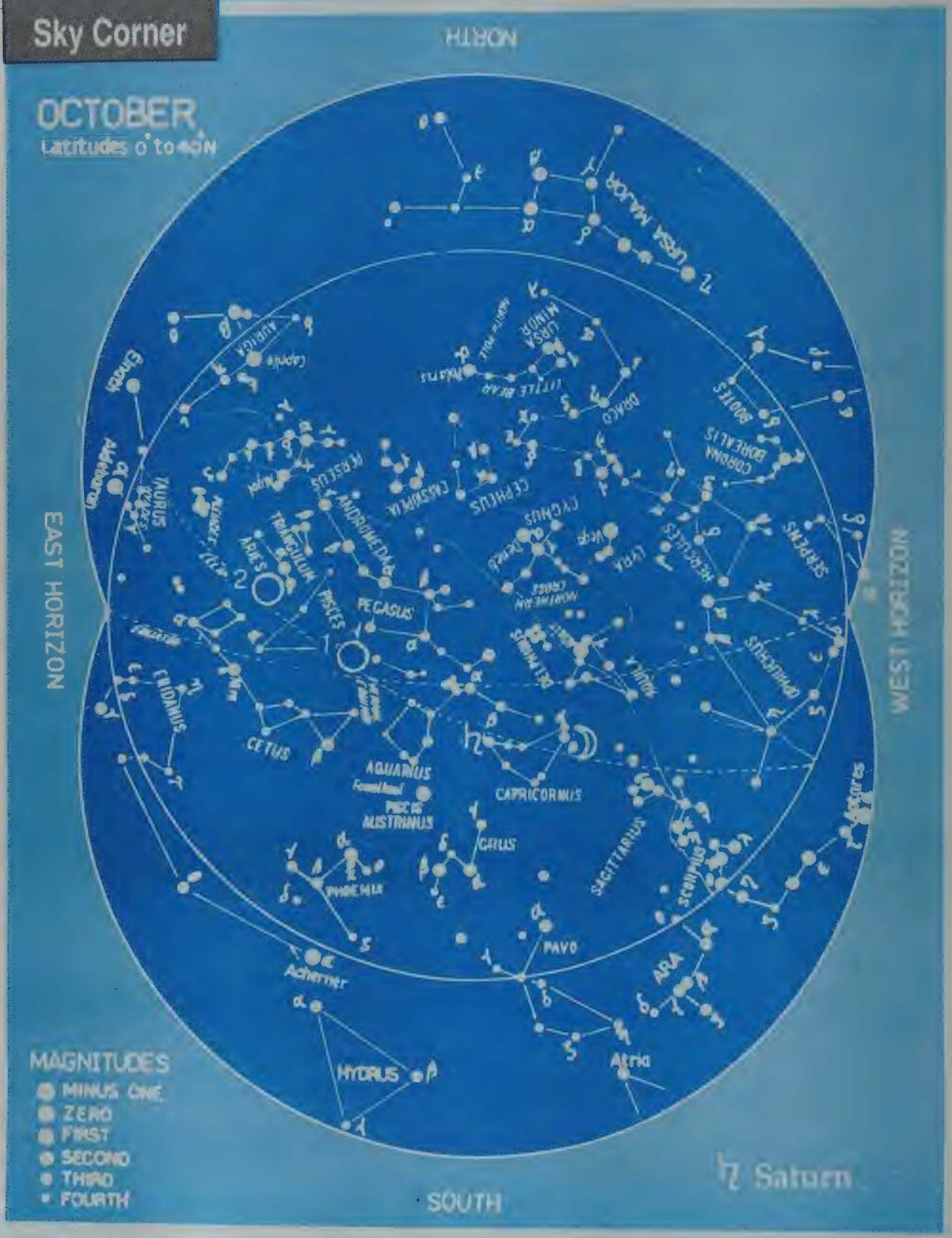
Professor S.N. Bose and Professor D.M. Bose at the former's 80th Birthday in 1974

D.M. Bose's main area of research was the study of nuclear collisions and disintegration by means of Wilson cloud chamber and photographic emulsions. With the modified cloud chamber he developed in Germany, Bose was able to verify Darwin's formula for collision between fast moving charged particles and molecules. He also made some studies on delta-particles.

On his return to Calcutta Bose constructed an indigenous cloud chamber. He took photographs of recoil tracks of radioactive nuclei during the process of alpha-particle emission, and of the simultaneous emission of two ionizing electron tracks from a helium atom, due to collision with an alpha-particle. One photograph obtained by him was later interpreted as showing the disintegration of a nitrogen nucleus. Quite some time later P.M.S. Blackett, who went on to win the Nobel Prize, revealed the way in which a stable atomic nucleus can be disintegrated by bombarding it with alpha particles. The photograph published in *Nature* in 1923 elicited a warm letter of appreciation from Lord Rutherford.

After joining the Bose Institute in 1938 Bose took up the study of tracks of cosmic ray ionizing particles using the photographic emulsion technique. He determined the mass of mu-mesons by this method. With the departure of his associate Bibha Choudhri to England in 1945 this work was discontinued as improved types of photographic emulsion could not be prepared. Later on, Cecil Frank Powell, a British physicist was able to prepare such improved emulsions. Powell was awarded the Nobel Prize in Physics in 1950 for his investigations along this line. He actually acknowledged the priority of Bose and Choudhri's work about mu-mesons during the

(Continued on page 35)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OCTOBER
Latitudes 0° to 40°N
EAST HORIZON
WEST HORIZON
SOUTH
URSA MAJOR
URSA MINOR
DRACO
CEPHEUS
CASSIOPEIA
PERSEUS
ANDROMEDA
TRIANGULUM
ARIES
PISCES
PEGASUS
AURIGA
TAURUS
ERIDANUS
CETUS
AQUARIUS
PISCIS AUSTRINUS
CAPRICORNUS
CYGNUS
LYRA
HERCULES
CORONA BOREALIS
BOOTES
SERPENS
OPHIUCHUS
SCORPIUS
SAGITTARIUS
CORVUS
HYDRUS
PAVO
ARA
Atria
Achernar
MAGNITUDES
MINUS ONE
ZERO
FIRST
SECOND
THIRD
FOURTH
Saturn

October

THE diagram shows the evening sky as seen from latitudes 0 to 40 degrees North. The inner circle represents the horizon as seen from latitude 22.5 degrees N. The chart has been extended on the northern and southern sides for use all over India. Beginners wanting to use the chart should hold it overhead and turn it in such a way that the North, South, East and West marked on the chart point to the correct directions. With some experience it would be possible to use it in a more convenient position. With the help of a few known star groups in the sky the remaining stars can be easily identified using the above chart. From a particular place these identified using the above chart. From a particular place these stars will be seen at about 2130 hrs. 2030 hrs. and 1930 hrs. of local mean time on the 1st, 16th, and 30th of the month.

The star chart meant for a particular day for a given hour can be used for the next day 4 minutes earlier and for the previous day 4 minutes later. For example, if a chart is meant for 8.30 pm for the 16th it can be used on the 17th at 8.26 pm and on the 15th at 8.34 pm. In the same way it can be used for other months; for the 16th September it will hold good at 10.30 pm and for the 16th November at 6.30 pm and so on.

The stars move from east to west in the sky in their daily motion (due to rotation of the Earth) at a rate of 15 degrees per hour. The chart can also be used at other hours in the evenings after taking into account the above shift in position of the stars.

Planetary Positions for October 1993

Date	*1st*		*10th*		*20th*	
Planets	*R.A.*	*Decln.*	*R.A.*	*Decln.*	*R.A.*	*Decln.*
Mercury	13h 49m	12.9S	14h 32m	17.6S	15h 09m	20.9S
Venus	10h 54m	8.4N	1h 35m	4.3N	12h 21m	0.5S
Mars	14h 02m	12.4S	14h 25m	14.5S	14h 53m	16.7S
Jupiter	13h 20m	7.3S	13h 28m	8.0S	13h 36m	8.8S
Saturn	21h 48m	14.9S	21h 47m	15.0S	21h 46m	15.1S

Adapted from figures supplied by Positional Astronomy Centre, Calcutta.

The Moon

THE full moon occurs on 1st at 00.24 a.m. and again on 30th at 6.08 p.m. and the new moon occurs on 15th at 5.06 p.m. I.S.T. The moon passes about six and a half degrees south of Venus on 14th, one and a half degrees south of Mars and about two degrees north of Mercury on 17th and about seven degrees north of Saturn in the evening of 24th.

The moon is at apogee or farthest from the Earth on 1st and again on 28th and is at perigee or nearest to it on 15th.

The lunar crescent becomes first visible after the new moon day in the evening of 17th except in the southern and western part of the country where it is likely to be visible on 16th.

The Planets

Mercury *(Budha)*, visible in the evening sky, sets about an hour after sunset during the month being in greatest eastern elongation of about 25 degrees from the Sun on 14th. At the end of the month it becomes too close to the Sun to be visible. It becomes retrograde on 26th. It is in Libra *(Tula)*. Its visual magnitude varies from -0.1 to + 1.0.

Venus *(Sukra)*, visible in the morning sky rises about one and a half hours before sunrise during the month. It moves from Leo *(Simha)*, to Virgo *(Kanya)*. Its visual magnitude is about -3.9.

Mars *(Mangala)*, visible in the evening sky sets about an hour after sunset during the first three quarter of the month. Thereafter it comes too close to the Sun to be visible. It is Libra *(Tula)*. Its visual magnitude is about +1.6.

Jupiter *(Brihaspati)*, visible in the evening sky sets about half an hour after sunset at the beginning of the month. Thereafter it comes too close to the sun to be visible being inconjunction with the Sun on 18th. At the end of the month it becomes again visible in the morning sky and rises about half an hour before sunrise. It moves from Virgo *(Kanya)* to Libra *(Tula)*.

Saturn *(Sani)*, visible in the evening sky sets about two hours after local midnight during the first half of the month and about an hour after it during the second half. It becomes direct on 28th. It moves from Aquarius *(Kumbha)* to Capricornus *(Makara)* by retrograde motion. Its visual magnitude is about +0.6.

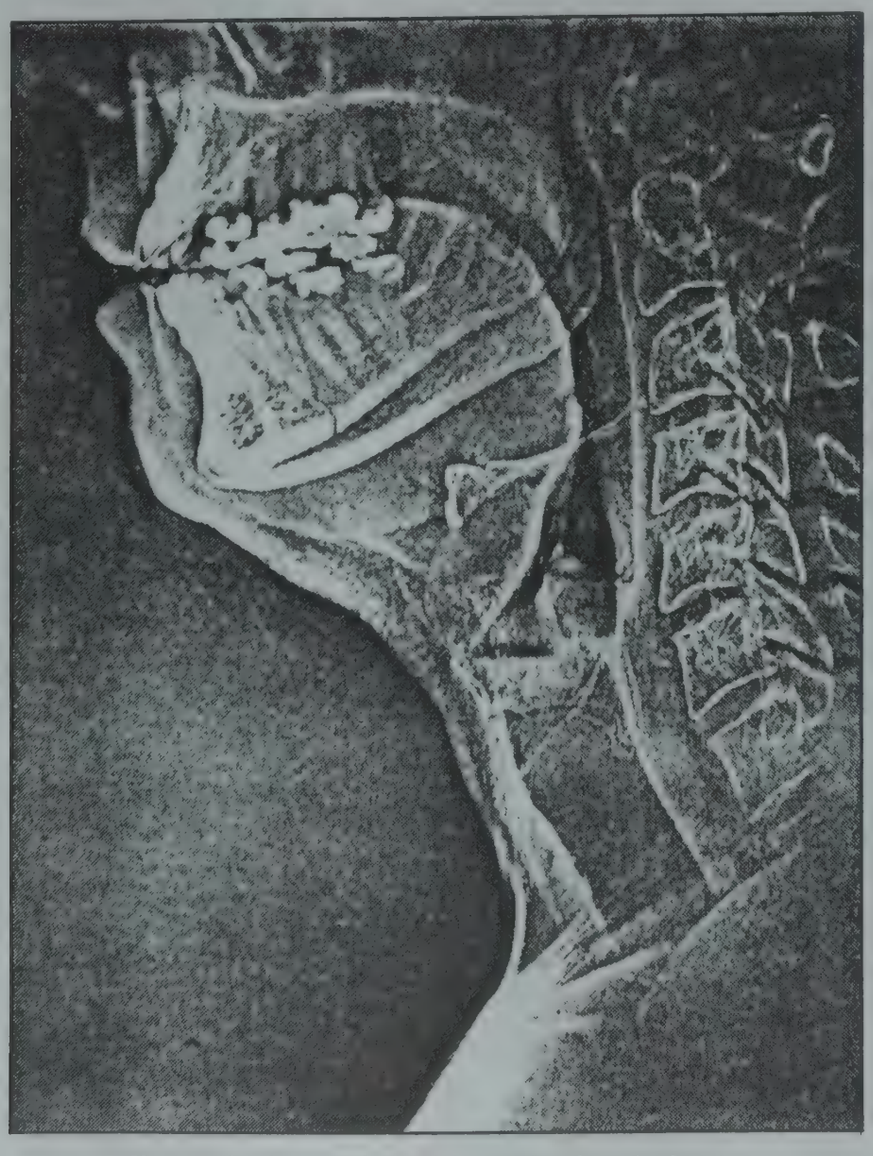
(Source : Positional Astronomy Centre, India Meteorological Department, New Alipore, Calcutta-700053)

SURESH NADKARNI

SEEING THE UNSEEN

WILHELM Conrad Roentgen, a German physicist, was awarded the first Nobel Prize for physics in 1901, for his discovery of X-rays. When studying the behaviour of electricity in vacuum in 1895, Roentgen found that a covered photographic plate had been exposed. He made a rapid yet thorough investigation of the event and within a few weeks was able to publish an account of the physical properties of the new rays, the use of the photographic plates or fluorescent screens to observe them and the degree of transparency to them of different substances including human tissues.

X-rays are radiations of very short wavelengths. They are used in medicine for therapy and for photography of the internal body parts. An electrical apparatus produces the radiation in a beam of the desired intensity and width by bombarding a tungsten target with high speed electrons in a vacuum tube. The versatility of X-ray examination is enhanced by purposeful modification of the X-ray beam used and the selection of recording medium, best adapted to the particular diagnostic problem. The tools of diagnostic radiology vary from 15 MA fluoroscopic unit to an elaborate 1500 MA X-ray unit with moving grid, automatic spot film device and the use of serial changers, as well as an image intensifier with a closed circuit television monitor and a camera attached to it.



X-ray technology can be used to examine the voice-box too

Some kinds of matter allow X-rays to pass through them while others obstruct them to a greater or lesser extent. Dense heavy substances are most impermeable to X-rays (radiopaque). For instance, lead glass is radiopaque beacuse it contains a heavy metal. Radiopacity is a matter of degree and different textures can be distinguished by the density of their shadows on a photographic plate or a fluorescent screen. Bones are so much denser than other tissue that they can be examined in great detail. On the other hand, lungs, consisting mainly of air, cast very little shadow and therefore abnormalities such as patches of inflammation are easily distinguished. The amount of radiation passing through the body and acting on photosensitive X-ray film decides the blackening of the film. Thus in the final picture lungs appear dark and the spine appears white.

Many organs can be examined with X-rays after suitable preparation. Barium sulfate casts a heavy shadow and is so insoluble that it can be swallowed with no risk of being absorbed from the intestine. When a suspension of barium sulfate has been swallowed a series of X-ray pictures will show its progress along the oesophagus, stomach and intestines. With a fluorescent screen the movements of these organs can thus be studied.

X-ray of a leg showing bones literally pinned and bolted together after an accident

Compounds of iodine are also radiopaque and can be used to study many organs. Those that are excreted into urine cast shadows of the kidneys. Others excreted into the bile are used for examining the gall bladder. These methods provide clear silhouettes of the urinary or bile passages. They also indicate the efficiency of these systems by the rate at which the radiopaque substance is excreted.

Instead of radiopaque substance, air can be injected into a space (a dye is also used for the purpose) such as ventricles of the brain to provide contrast in X-ray picture. By one or other such method most organs can be studied.

X-ray examination of chest provides valuable information about the size of the heart, the condition of great vessels, ribs, lungs, and diaphragm. Diseases like pneumonia, tuberculosis, chronic bronchitis, lung abscess are easily diagnosed by a radiologist. Industrial lung disease, due to inhalation of dust or fumes, can also be detected on X-ray examination of the chest. Amoebiasis, toxoplasmosis, kala-azar, trypanosomiasis and such other infections produce varied radiological appearances. Worms and hydatid organisms, echinococcus, can be also seen in X-rays. Tumours and cancer of lungs can be diagnosed on plain X-ray of the chest.

Dilated heart is seen in plain X-ray of chest. Angiography in which a radiopaque dye is injected to visualise the blood vessels of the heart adds a new dimension to this. Fluid collection in the wall of the heart, called pericarditis, is also revealed on plain X-ray.

Barium meal uncovers pathology of the gastro-intestinal tract. The sphincter muscle at the lower end of oesophagus does not open when food reaches there — a condition known as achalasia. The achalasia can be seen after a barium meal. Sometimes a part of the stomach climbs up into the chest. This condition called the hiatus hernia can also be found out by a barium meal. Deformed duodenal cap visualised by a barium-meal, is indicative of pepticulcer. Diseases like tuberculosis of intestines can also be diagnosed using X-rays.

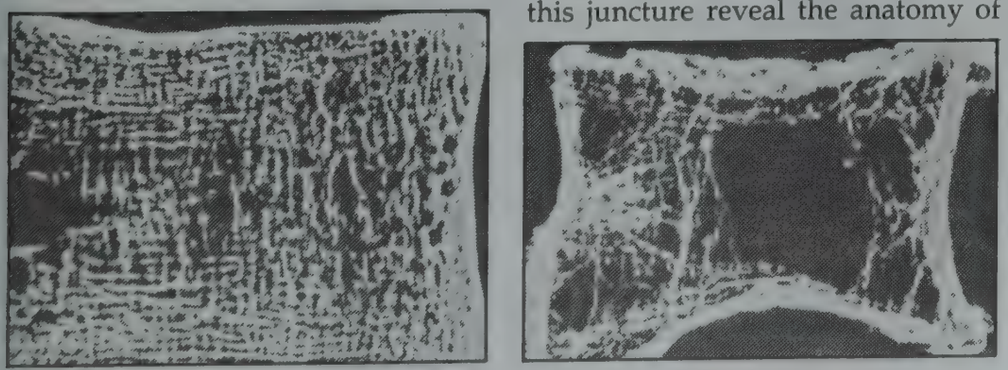
Gall-bladder stones are seen on plain X-ray abdomen. Only 10 percent of the gall stones are opaque. To visualise the transparent stones dye-tablets are given orally to the patient. This dye concentrates in the gall bladder after 8-12 hours. Pictures taken at this juncture reveal the anatomy of the gall bladder, as well as the transparent stones.

X-rays of chest are taken in selected planes — this is called tomography. Injecting a dye in branches of the windpipe in the lung clearly shows the bronchial tree. This is called bronchography.

X-rays of skull are also taken to diagnose fractures of skull, collection of blood in the coverings of the brains, the increased tension in the skull on account of meningitis, brain tumours, or calcifications in brain on account of tuberculosis. Plain X-ray of the spine reveals tuberculosis, fractures, prolapsed discs, and ankylosing spondylitis. A dye like myodil is injected in the coverings of the spinal cord and myelography is done. This reveals the pathology of the spine. Blood disorders such as Haemophilia, leukaemia, multiple myeloma, myeloid leukaemia can also be diagnosed by X-rays, only to be confirmed on further investigation.

X-rays destroy certain kinds of abnormal tissue more rapidly than normal tissues. Hence they can be used to reduce or eliminate cancer and other abnormal growths without excessively damaging the surrounding healthy tissues. Various skin disorders, including bacterial and fungal, have been effectively treated with X-rays.

X-rays thus have proved to be very useful in the field of diagnostic medicine. However an overexposure to X-rays can be at times hazardous. Pregnant women should avoid X-ray examination as far as possible. Frequent X-rays of pregnant women has been known to give rise to higher incidence of breast cancer. Hence the great usefulness of X-rays is limited by their harmful possibilities. Excessive exposure to the radiation can produce skin disorders, X-ray dermatitis, loss of hairs and nails, anemia and cancer. So 'GO SLOW ON X-RAYS' is the message.



X-ray of a normal vertebra (left). On the right is the X-ray of an osteoporotic bone where the affected areas look blacker

Dr. Nadkarni is a practising physician. Address : Flat 38-39, 5th Floor, Municipal Building, Jobanputra Compound, Nana Chowk, Bombay-400 007

"No easy solution..."

This is with reference to your editorial entitled **Pride and Prejudice** in July 1993 issue of the Science Reporter. "Brain Drain" has been an issue which had been causing great concern. While a greater concern had always been about the migration to developed countries of our bright young men and women educated at a great cost to the nation, using the scarce resources available, the internal migration or "internal brain drain" which has been taking place had not been generally talked about with as great å concern. It is in this context that we were very happy to read this editorial in your esteemed magazine. Civil Services is certainly not the only kind of a non-engineering career to which engineers turn to. There are many engineers who take up other careers ranging from politics to journalism, banking to advertising or marketing of consumer goods, which have very little to do with engineering. There are also many cases where, though trained for one particular profession, engineers take up careers in areas in which their specialisation may not have much relevance.

There cannot be a magic solution to such a problem, which is due to various socio-economic factors. It is not really fair to hold the student joining a professional course totally responsible for deciding to take up jobs and careers unrelated to the profession for which he or she has been trained. We the members of Indian society cannot escape sharing the blame. Those youngsters, are only reflecting the values that we have acquired, and passed on to our youngsters over the years. One can think of a number of negative or restrictive methods to arrest such Internal Brain Drain. However, it may be better to first think of various positive and constructive ways of tackling such problems. Coming specifically to the issue of Civil Services, a solution seems to be conduction of the examination for selection to the Civil Services for those passing out at the 12th standard, like the examination for the selection to National Defence Academy and a career in the Defence Services. Those interested in Civil Services could then be selected at that stage itself and thereafter trained in selected institutions to prepare them for their careers as Civil Servants. Only the remaining would then take to other professional courses like engineering, medicine and so on they would atleast not migrate to Civil Services after their professional course. However, this is also not going to solve the problem totally because there would still be a large number of these professionals taking up careers which are totally unrelated to the professions for which they have been trained. The appropriate solution to the problem perhaps, therefore, lies in facilitating school students to have a clearer perception of various career options and ways to attain their career goals, through proper career counselling.

Some of us at IIT Kharagpur had been thinking for some time of this problem of "Internal Brain Drain" and decided that instead of talking about it in general terms without facts and figures, we would study this type of Brain Drain, to analyse its characteristics and come up with possible intervention strategies to combat the same. While the in-depth study would be limited to IIT Graduate Engineers, due to practical constraints, we hope to generally cover the phenomenon, at least in respect of internal migration of engineers. Hopefully, therefore, this study should bring out relevant information which may help educationists and planners to find a way to handle this problem.

We would like to have your cooperation in this connection, and request readers of *Science Reporter*, through your columns to please respond to the following questionnaire.

Response from bright young school students seriously trying for admission to IITs and Engineering colleges with a clear idea of later switching over to Civil Service or other Non-engineering careers, those currently at IITs and Engineering Colleges seriously trying for these career options and those already in an engineering profession hoping to switch over to Civil Service or non-engineering careers, would be particularly welcome. Civil Servants and others currently engaged in non-engineering careers, after an engineering degree, should they see this letter, could also help us with their response. Response from members of various interview boards who may have had opportunities to discuss this issue with candidates with engineering background wanting to migrate to Civil Service and Non-engineering professions, from journalists who may have interviewed such persons and teachers who have discussed career plans of their students would also be of great help. The response does not necessarily have to be in the form of answers to the question raised.

The Questionnaire

1. To which of the following category do you belong to (a), (b), (c), (d) or (e)

   (a) Engineering graduate in IAS/IFS/IPS/Other Services

   (b) Engineering graduate in other non-engineering professions

   (c) Engineering graduate trying for non-engineering careers including (a) above

   (d) Engineering College student planning to take up non-engineering career including (a) above

   (e) School students planning to first join engineering degree course and later switch to non-engineering careers including (a) above.

2. Specific category of the service if in civil service or what kind of a non-engineering career are you in ? Specify_____

3. Why did or do you prefer a non-engineering career? *(Tick the best three reasons)*

   a) better prestige and power

   b) better pay and perks

   c) better job satisfaction and challenge

   d) faster career growth

   e) more opportunities to serve people

   f) lack of adequate career opportunities in field of engineering specialised

   g) lack of interest (developed now) in an engineering career ?

   h) pressure from family and friends

4. At what stage do or did you decide to pursue non-engineering career ?

   a) Before joining engineering course

   b) During the engineering course

   c) After taking the engineering degree

5. Who influenced you most for choosing a non-engineering career ?

   a) Parents (mention father, mother or both and their background)

   b) Relative (mention relationship and background of person)

   c) Teacher (at which class and level)

   d) Any career counsellor (where ?)

   e) Peers or friends (what is their background ?)

   f) Decision taken by self solely

6. If you are in a non-engineering career already, do you now wish that you had followed an engineering career ? Yes/No (Why_____?)

7. Did you at any time wish that you had the benefit of seeking advice from a professional career counsellor ? Yes/No/Not certain

Your Name :

Address :

If employed, Designation :

Organisation :

If student, Class and School or College :

In addition to the questionnaire the respondents can also write their views about the questions raised. All sources of information will be treated as confidential. Completed questionnaire may be sent directly to :

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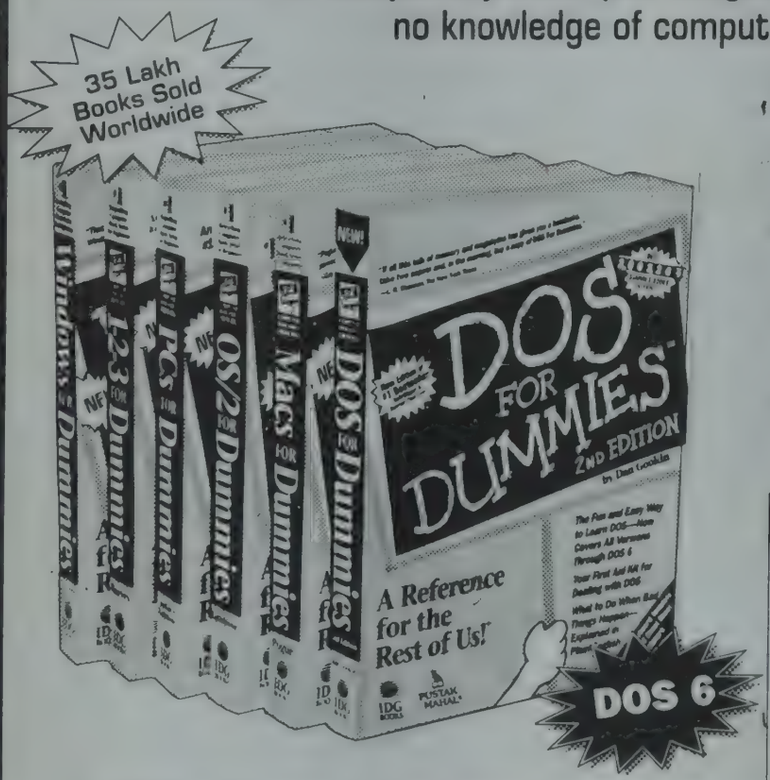

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PRIZE WINNER

Why does a thirsty person prefer to take cold water than warm water to quench his thirst ?

Saranjit Poddar
Banarpal (Orissa)

Thirst is felt when the thirst center — a collection of nerve cells at the base of the brain—senses that the water level in the blood is low. Thirst is also sensed by thirst center when the lining of the throat goes dry. This happens because the nerves underlying the lining get stimulated when the lining goes dry and send messages to the brain. These excited nerves are soothed by cold water or other cold drinks more easily than warm water. Why it should be so is still not clear.

Kollegala Sharma

Why do our hands and lips get chapped in winter ?

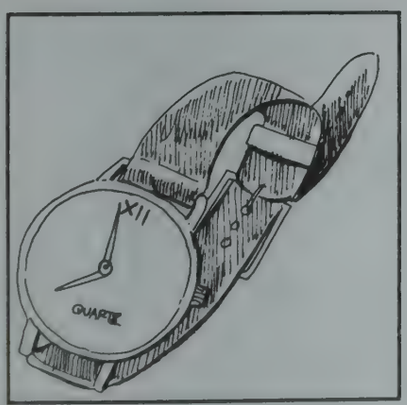
Danish
Gaya (Bihar)

Our hands and lips get chapped because of the extreme dryness of the air. The skin remains soft when it is moist. It is moistened by the secretion of sweat from sweat glands present in the inner layers of skin. When the outside air is extremely dry, skin loses moisture and turns dry. It also loses its elasticity and thus gets chapped or cracked. Although chapping occurs all over the body, it shows up prominently at places where the skin is very thin like the lips and hands. Chapping, to some extent, can be prevented by applying grease or oil or cold creams which prevent moisture loss from the skin.

Kollegala Sharma

Why are the quartz clocks so called?

Chinmoy Mohanty
Santiniketan (W. B.)



A quartz crystal is the heart of all quartz clocks and hence the name. These clocks make use of the piezoelectric property of the quartz crystal which makes them vibrate at a constant frequency when an alternating voltage is applied across it. In ordinary clocks and watches an oscillating balance-wheel driven by a spring keeps the time and moves the clock hands. In quartz clocks the quartz crystal does this job. It is set in an oscillating electric circuit in which the voltage oscillates with a frequency equalling that of the natural frequency of vibrations of the crystal. Thus the entire system oscillates with the natural frequency of vibration of the crystal. This oscillating voltage which is maintained at a constant value by the vibrating crystal is used to run a tiny stepping motor which drives a gear train, which in turn move the hands on the clock face.

Neeru Vig

Brains Trust

Why is it not possible to run fast with our hands tied?

Abhijit Ganguly
Bombay (Maharashtra)

The simultaneous swinging movement of our arms and legs help our body maintain the balance while walking or running. When we are in the standing position the centre of gravity of our body falls on our feet and so our body remains well balanced. While walking and running we open our legs making the position of the centre of gravity shift forwards. If we tie our hands there are chances that we would lose our balance and topple over. This does not happen normally because the periodic forward and backward motion of our arms and legs are opposite to each other which helps in positioning the centre of gravity of our body always within the base of the body and maintain the balance. As this cannot be done with the hands tied, it becomes difficult to maintain the balance while running or walking.

Neeru Vig

Why does one beat dirty clothes on a stone or floor during washing?

Sitangshu Sarkar
Eruthiampathy (Kerala)

Clothes get dirty because dirt particles get attached to grease or other oily materials which somehow gather on our clothes by contact with oily or greasy surfaces. These dirt particles can not be easily removed just by dipping the clothes in water. Soap, detergents or washing soda are needed to wash them off. The soap or detergents reduces the surface tension between the grease and water and thus the grease along with the dirt get detached from the cloth fibres. But dirt particles lodged between fibres often remain and are difficult to remove. When we beat the clothes either on a stone or the floor, these difficult-to-remove dirt particles are dislodged and can be removed easily from the cloth.

Madhu Sahni

Why does our skin become wrinkled in old age?

Neerad Kumar Bhuniya
Burdwan (W. B.)

Wrinkling of skin is a sign of old age. Our skin becomes wrinkled because of changes in the underlying structure. There are some connective tissues just under the outer layer of the skin which are made up of two types of protein fibres—collagen and elastin. The collagen provides the material for the tissue and the elastin fibres, which are smaller in number, give elasticity and suppleness to the skin. With time, as one ages, the amount of elastin in the skin diminishes and the collagen fibres become disorganized. The cross-linking between collagen fibres also increases. Consequently the tissue gradually loses its elasticity. Thus wrinkles appear on the face and other parts of the body. Another factor responsible for the development of wrinkles is sunlight. The ultraviolet part of the sunlight accelerates the changes in the skin which cause wrinkles.

Madhu Sahni

DEBENDRA MOHAN BOSE

(Continued from Page 25)

course of his lecture at Bose Institute sometime later.

Professor Bose made a special study of the plant physiological investigations of Sir J.C. Bose who had shown that plants respond to external stimulus. D.M. Bose suggested that there were certain biochemical processes that intervened between stimulation and mechanical response in plants. He initiated the investigation regarding the source of energy of mechanical response in plant organs, including the spontaneous pulsation of leaflets of *Desmodium gyrans*.

Both as Professor of Physics in the University College of Science and as Director of the Bose Institute, D.M. Bose trained and inspired a generation of scientists. He initiated several lines of investigation during his tenure. The time-variation and altitude-dependence of cosmic rays was measured using a Compton-Bennet type of Ionization Chamber. Several interesting cases of sudden variations in cosmic ray intensity associated with solar flares and magnetic storms were recorded. For work in neutron physics, a 14.5 MeV neutron generator was fabricated and operated at the Bose Institute under Professor Bose's guidance. Incidentally, it was the first instrument of its kind to be installed in India.

In 1919 after his return from Europe Dr Bose married Nalini Sircar, the eldest daughter of Nil Ratan Sircar, the renowned chemist.

"Bose was a man of few words, and more or less a silent worker, inspite of his vast erudition and wide interest," says S.D. Chatterjee, Professor Bose's colleague. "Bose avoided both the limelight of public applause and the patronage of the powers that be. His nature and his uncomprising principles were praiseworthy,"

Due to exposure to several cultural figures during his childhood Bose evinced keen interest in social and cultural matters. He was closely associated with the management of the City College and the Sadharan Brahmo Samaj. He served the Viswabharati University as its Honorary Treasurer for about 18 years. Professor Bose was deeply interested in the history of science. He was one of the editors-in-chief *of A Concise History of Science of India*, a publication of the Indian National Science Academy. He was also the editor-in-chief of the *Indian Journal of History of Science* published by INSA.

Professor Bose had been in the habit of taking long walks. But while in Germany he started suffering from arthritis. This put an end to his long walks. But still he would walk to the Bose Institute and back home a few times every day. Eventually failing health forced Professor Bose to take retirement from the Institute. He passed away in the morning hours of 2 June 1975. □

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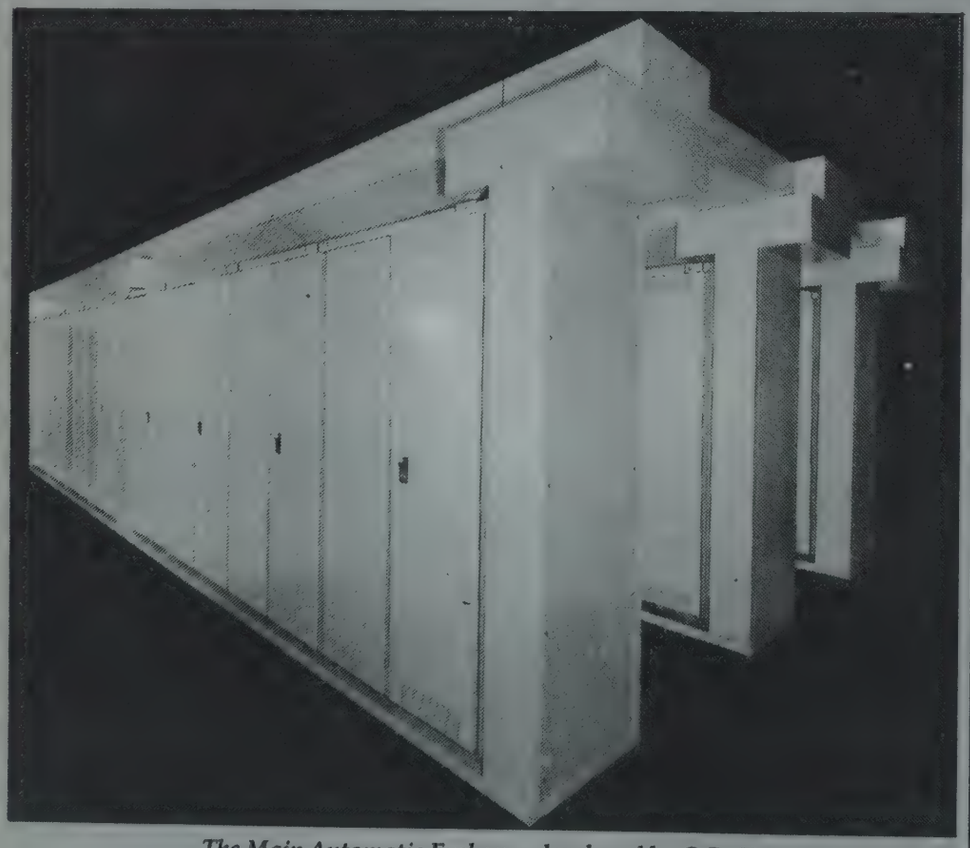
A RESOUNDING SUCCESS

(Continued from Page 15)

Thinking Big!

IN trying to develop successful telephone exchanges for the rural population, Indian scientists and technologists have not overlooked the large urban population which is so very dependent on a functional telecom network. The Centre for Development of Telematics has also developed large telephone exchanges of upto 10,000 line capacity. These are called the 'Main Automatic Exchange' or MAX.



The Main Automatic Exchange developed by C-DoT

Thirtythree of these indigenously built exchanges have been delivered of which fifteen have already been installed. The first MAX to be installed was at the Ulsoor exchange in Bangalore. Today about 9,700 lines have already been connected. One of the main criteria for assessing whether a system is successful or not is what is called the 'busy hour call attempts' (BHCA) which pertains to the maximum number of calls that an exchange can put through at peak hours. The Ulsoor exchange regularly has about 95,000 BHCA between 10.45 AM and 11.45 AM which has at times been upto one lakh five thousand calls. It compares well with other imported exchanges.

A still larger MAX-L having a capacity of 40,000 lines is in the process of being installed at Delhi Cantonment. The MAX-SL or super large which will have a BHCA of 800,000 is planned to be ready by the year 1995. Developing such large exchanges is not an easy job, for, computer programs running into hundreds of thousands of lines have to be written, tested and debugged in short spans of time. There is no doubt that there have been time overruns in developing the MAX but these are the sort of failures that become the stepping stones to future success.

P.B.

The Indian telecom network has a five-level hierarchy. The upper most is the main switching centre and the lowest is the terminal exchange. In between are the primary, secondary and tertiary exchanges. The 256-port RAX can be placed both at the tertiary level and at the terminal exchange level, that is, where it connects to the subscriber directly. But making good bridges alone does not provide better road transport, the roads also need to be well surfaced to provide a trouble free ride. The RAX is like having good bridges. The telephone lines or transmission equipment — which can be related to roads — also need to be as good. Today, a large part of the problem in the telecom sector lies in the obsolete and poor quality telephone lines. This handicap of providing reliable long-distance telephone lines is being rapidly overcome with the increasing use of satellites. The INSAT generation of geostationary satellites came as a real boon to the telecom users. Now with INSAT-2B in place one can expect another quantum leap in terms of the ever widening telecom network. Many trunk lines are also being replaced by optical fiber cables which can carry many times more number of calls as compared to the traditional copper wires.

Small places like Kittur and Anekal can now avail of modern telecom facilities like STD and ISD, call waiting, morning alarm and itemised billing among others. All these have been incorporated into the RAX to provide efficient and smooth telecom service.

It is a pleasure to see these modern rural automatic exchanges working, the environs are so peaceful for there is no humming, buzzing and clanging of electromechanical relay equipment. The operators — if there are any — are not a harried lot. Everything else aside, the telephone users seem a happier and contented lot because of better services they get. □

TWO YEARS OF BOLD INITIATIVES

PROMOTE GROWTH, BRING STABILITY

Right from the day it assumed office on 21st June, 1991, the Narasimha Rao Government had stepped forward with bold changes to revive the Economy and put India firmly on the Growth Path.

As a result of New Economic Measures

- Industrial production picks up.
- Licensing abolished except for 15 industries. Domestic investment increases.
- Foreign equity investment approvals total to nearly Rs.7,622 crore in the last two years.
- Inflation rate comes down to 5.8 per cent from 17 per cent in August, 1991. Rise in prices of essential commodities checked.
- Foreign exchange reserves swell to over 6,670 million Dollars as against 1,100 million dollars in June, 1991. Balance of Payment stabilised.
- Trade Policy reforms, including full convertibility of Rupee on trade account, help growth in exports.

Better Life for Rural Poor

- Centre provides Rs.30,000 crore for Rural Development in the 8th Five Year Plan.
- Over 4.22 crore families assisted under Integrated Rural Development Programme - total investment, over Rs.18,000 crore.
- More Than 154 crore days' employment to rural labour under Jawahar Rozgar Yojana.
- Nearly 1.5 lakh youth trained under scheme for Training of Rural Youth for Self-Employment.
- Engagement of manual scavengers made punishable; scheme of low cost sanitation to liberate scavengers operating in 760 towns.

Public Distribution System to Benefit Backward Areas

- Public Distribution System revamped in January, 1992. Special attention to 1700 blocks in identified backward areas.

- 11,000 new ration shops opened in these PDS areas.
- Issue price reduced by Rs.50 per quintal for wheat and rice in identified areas since June, 1992.

Full Attention to Farm Sector

- Boost to agriculture and agro-industries; investment up. Higher prices for farm produce and other incentives. New deal for farmers through new agricultural policy.

- Record food production and record Government purchases. Nearly 122 lakh tonnes of wheat and 115 lakh tonnes of rice procured.
- A massive Rs.756 crore fertilizer subsidy to farmers for 1993-94. Rs.340 crore subsidy given for 1992-93 Rabi season.
- Complex fertilizers to farmers at concesssional rates. More fertilizers at fair prices.

Communicating with the People

- Doordarshan with 550 transmitters reaches over 83 per cent of population. A.I.R. network expanded from 121 to 154 stations covering almost the entire country.
- Metro TV Channel programmes can now be seen in other parts of the country.
- Four new TV channels for Doordarshan for sports, business, news and current affairs, and music.

Some Major Steps

- National Renewal Fund set up to protect industrial workers likely to be affected by modernisation.
- Private sector brought into the fields of power generation and distribution, iron and steel industry and mining to improve performance.
- Speedier rail service through conversion of 6000 kilometres of metre gauge rail line into broad gauge.
- More funds for health and education; literacy campaign gains momentum
- Result oriented Action Plan to promote small family norm.

Power to the People

- More powers given to Panchayats under the Constitution.
- Agriculture, land improvement, animal husbandry, village and cottage industries, drinking water, poverty alleviation programmes, health, sanitation and family welfare to be the concern of village panchayats.
- Women given more power. Women to get 3 out of 10 seats in Panchayati Raj institutions.
- More power given to SCs and STs and Backward Classes through reservation of seats in Panchayati Raj institutions.
- Steps taken to implement Mandal Commission recommendations for job reservations.

Maintenance of Law and Order

- Normalcy restored in Punjab and Assam.
- All-out efforts to resolve Ayodhya issue. Reference made to the Supreme Court; proposal for formation of Trusts for construction of temple and mosque.
- Initiatives taken to improve the situation in Jammu & Kashmir.

India Steps Forward

davp 93/206

Thou Shalt Not Lie

SUKANYA DATTA

JHUT boley kaua katey kale kaue se dariyo run the lyrics of a popular Hindi movie song. Roughly translated, it means 'Beware of the black crow for it will peck the liar'. What a simplistic way to identify the liar! In reality, however, it is not so easy.

Dislike and mistrust for the untruthful has been common to all human societies down the ages. Irrespective of their level of sophistication, all human societies have condemned lying. 'Don't lie' is perhaps the first and most common admonishment a child hears. But while many childish lies are flights of imagination or else white lies, exposing a liar and catching out the lie may assume serious proportions in an adult world. And this is where the lie-detector steps in.

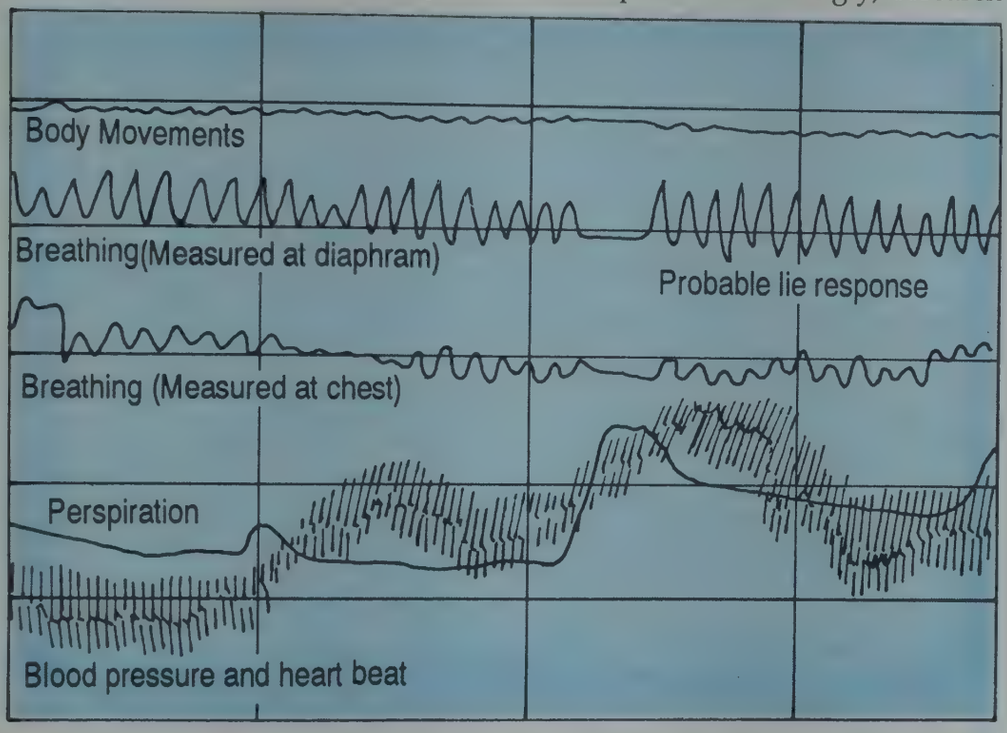
A lie-detector (as its name suggests) or polygraph, is a device used to help determine whether a person is lying. The device records variations in the physiological responses of individuals subjected to a series of questions which may or may not cause stress. A polygraph relies on fairly simple measurements to assess the amount of stress caused by these questions. It operates on the assumption that lying is a stressful experience which causes a physiological backlash in the body. The idea of having a lie-detector to catch a liar is not a new one. It originated in the 4th century BC when a Greek physician assumed that a quickening of the pulse was indicative of emotional stress caused by lying. He assumed that lying does not come naturally to man and that when a person has to lie, he is under considerable mental pressure that gives rise to detectable physical signs. This line of reasoning was further explored by one Lombroso in the 19th century. Lombroso tried to correlate changes in blood pressure to stress. In 1915, an American, W.M. Marston devised the grand daddy of all modern lie detectors. John A. Larson (1921) and Leonarde Keeler (1926) of USA further elaborated the principles on which the lie-detector worked when they developed techniques for recording blood pressure and patterns of respiration. W.G. Summers (1936) and John Reid (1945) also made important improvements in the polygraph. Soon it became necessary for the lie detection organizations to gather under one umbrella and in 1966 the American Polygraph Association was formed. It helps supervise the use of lie detectors and establishes qualifications for the examiners. The refinements in the design of polygraphs, however, did not stop. In 1972, American inventor Allen Bell developed a device called 'Psychological stress evaluator'. This instrument which detects slight tremblings in the voice, which may be interpreted as an indication of the speaker trying to hide something, is considered a useful adjunct to the polygraph. Advances in polygraph design seems to have reached a saturation point and the consensus among experts is that the existing instrumentation is adequate for interpretation. This does not, however, imply that more convenient models of the polygraph cannot be designed. On the contrary the changes in the future will probably lead to lighter, more durable models, preferably battery operated ones. Also, changes are likely to evolve in question formulation and chart interpretation.

One may ask: Is the polygraph reliable? Infallible? Can one mislead or trick it? In short, can one lie to the lie detector? The answer, most unexpectedly, is 'yes'. To understand this seeming paradox one has to understand how a polygraph works.

Although there are several types of polygraphs, including a device for monitoring respiration at short distances by directing a microwave signal at the stomach of the person, a typical unit consists of equipment that measures the action of the heart, changes in the pattern of respiration and changes in the electrodermal response.

In addition, a device to measure "stress" in the respondent's voice may also be used. This does not require attachments to the body and can be used covertly. The respondent is thus physically connected to a cardiosphygmograph, a pneumograph and a galvanograph. The cardiosphygmograph consists of a bladder and cuff arrangement connected to the instrument panel by a simple tube which translates, via a bellows and lever system variations in blood pressure and pulse rate. It is placed just over the brachial artery (between the armpit and the elbow) and the variations in the relative pulse rate and blood pressure are recorded on a graph. The pneumograph records the breathing pattern. It is a rubber tube placed around the person's chest. variations in chest volume actuate the pneumograph and the impulses are transmitted to a bellows and lever system which moves a pen recorder. The inconsistencies in the resulting graph denote the changes in the respiration rate and this gives clues to the veracity of the subject's statements. A galvanograph records the resistance of the skin to the passage of an electric current. An electrode is attached to the subject's hand or finger and con-

nected to instrument panel where the graph is recorded. The skin of a relaxed person has a low electrical conductance and the skin surface is about 40 mV negative with respect to interior tissue. Sweating can change the electrical properties by increasing skin conductance and by changing the balance of positive and negative ions in the secreted fluid. Sweating, especially on the palms and soles varies with the psychological state of the individual. Skin conductance rises sharply under stress. The amplitude of skin conductance varies with nature of the question, its probable meaning and whether it comes as a surprise for the respondent. Electrodermal responses are believed to have especial significance in studies relating to emotion and stress. A polygraph can measure even very small changes in skin conductance because they are amplified before being fed into the galvanometer which drives a pen recorder.



The moment a person starts lying, the different graphs recording his reactions go awry

NOW that the subject is wired up he has to face a battery of questions. Some of the questions asked during the test are related to the matter under investigation but others may be totally unrelated or only slightly related. Typically, to a series of 8-12 questions the person answers a simple 'Yes' or 'No'. There is no specific "lie-response" but experts can determine from the polygraph recordings, if the "relevant questions" had greater impact on the subject than the interpolated unexpected "control questions". A typical relevant question could directly ask" On April Ist did you take Rs 10 thousand from the canteen cash reserve?" In contrast a control question might be vague, "In the first fifteen years of your life, did you ever steal anyting?" A stronger response to the relevant question is inferred to mean that the answer to this question is deceptive. Interestingly, research has shown that as many as 50 percent of innocent suspects may fail control-question polygraph tests. Another study conducted by the University of Pennsylvania in USA found that polygraph tests were biased against "highly socialized" or very honest people! Why is this so? This is because an innocent accused may be overly disturbed by the relevant questions and react more strongly to them than the control questions. This may cause large fluctuations on the graph which may be interpreted as strong emotional response indicative of a lie.

Then again, some people can exercise considerable control over their emotions while others are unsuitable subjects because of naturally occurring inconsistencies in their breathing and pulse rate. Pathological liars can retain their composure even in the face of the worst grilling while the emotionally labile crack under the very strain of being a suspect wired to the polygraph. Thus, a few subejcts are able to deceive the machine consciously while others may be falsely implicated. The 'voice stress' device too is not fail-proof. It is yet to be shown that these devices can reliably distinguish between different degrees of voice stress. Even when voice analyzers have been used in parallel with a polygraph they have performed no better than chance in sorting truth from deception.

The polygraph has often come in for a lot of criticism. It is unreliable and its unreliability springs from the very premise on which it operates. People do not always react the same way under stressful circumstances. While a suspect cannot be forced to take the test nor the results be admitted as evidence in court, a polygraph can help eliminate potential suspects who demonstrate no physical stress in responding to questions.

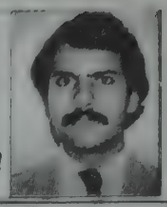
The chief criticism levelled against the polygraph is that the potential abuses of the instrument are manifold. But used properly, it can help a person to establish innocence in the first stages of a police investigation. It is basically a tool to establish innocence more than to find out the guilty. A polygraph has good potential for use in psychiatry to help pinpoint anxiety. Also the responses of the autonomous nervous system triggered by fear and stress could be studied using the polygraph.

Currently, however, a polygraph test has only dubious status. A cool head, nerves of steel and sheer audacity would win hands down against the impressive gadgetry. It is, after all, a direct confrontation of the human brain and mind against a man-made machine!

Dr Datta is with the Publications and Information Directorate, New Delhi

Use More Mind Power
for success in competitions

by Raj Bapna



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- Excellent course ... it has changed my life style. Increased my reading from 86 to 303 words per minutes in 5 days and strengthened my dream of success in AIIMS, All India etc.
  — *Dr Ratnakar Sahoo, SCB Medical College, Orissa*
- It is lucid, simple, powerful.
  — *Prof I J Nagrath, Deputy Director, BITS Pilani*
- Increased my reading from 100 to 350 in 2 days.
  — *Shashi K Singh, Computer Engineer, Dehradun (U P)*
- I topped the DAV College. Increased speed from 303 to 1000 words.
  — *Sanjeev Dixit, Panchkula, Haryana*

Answer These 6 Question?

- For better memory, should you study early in morning or late in night?
- For better memory, should you read faster or slower?
- Do examiners give more marks if you write more and fill more pages?
- Which vitamins can help your brain function better and improve your IQ?
- Should you study continuously or take rest?
- Why does eating before an exam reduces IQ?

Memory Secrets

The brain has two memory stores: short-term and long-term. Whatever you see, hear, or feel is processed by the brain. The irrelevant information is removed immediately. The remaining information goes into short-term memory. Whatever we revise again and again goes into long-term memory.

Without revision, in 24 hours we forget 82%. So, we remember only 18%.

As time passes without revision, we remember less and less. After one month we remember about 5%. Most people attend classes or make notes, but they do not revise enough, so they do not remember as much as they can, and their hard work is wasted.

My course will teach you a systematic technique to revise and remember more in less time. You can learn this powerful technique in just 30 minutes.

You will learn more secrets from my course.

Newspapers Say This Course Is ...

- Simple, effective, practical techniques to improve overall intelligence and mind power. Even average student can easily understand. — *Times of India*
- Powerful, practical, easy. It will help all students, bank officials and others appearing for test, exams and interviews. — *Indian Banks' Asso. Bulletin*
- It teaches how to succeed in exams and life-struggle. — *Malayala Manorama*

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Chapter 13. 32 Important questions & answers

Author's BIO-DATA

- The maximum the USA companies paid for me in a single month was $18,002 (over Rs 5 lakhs in one month). At peak of success, I left USA to return to India to teach my mind power study techniques. Now I spend my full time in research in India.
- B E, BITS Pilani. M Tech, IIT Kharagpur. NTS scholar. Rank 5 in Raj High School Board.
- World-famous author. Published 3 books in USA including my best selling book " Tricks of MS-DOS Masters", 721 pages, $27.95.
- Increased my reading speed from 72 words to as fast as 1037 words per minute.
- My first job as an engineer paid only Rs 1000 per MONTH. Finally, I earned $50 (Rs 1500) per HOUR in USA as a computer expert.
- Expert in computers, mind power, study techniques. Spent $1300 (about Rs 40,000) for 2 seminars in USA to learn the mind power techniques called Neuro-Linguistic Programming. Was a member of Society for Accelerated Learning & Teaching, USA.
- Learnt French, Sanskrit, Karate, Breaking wooden board by hand, many Meditations, etc.

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Hail Hairy Roots!

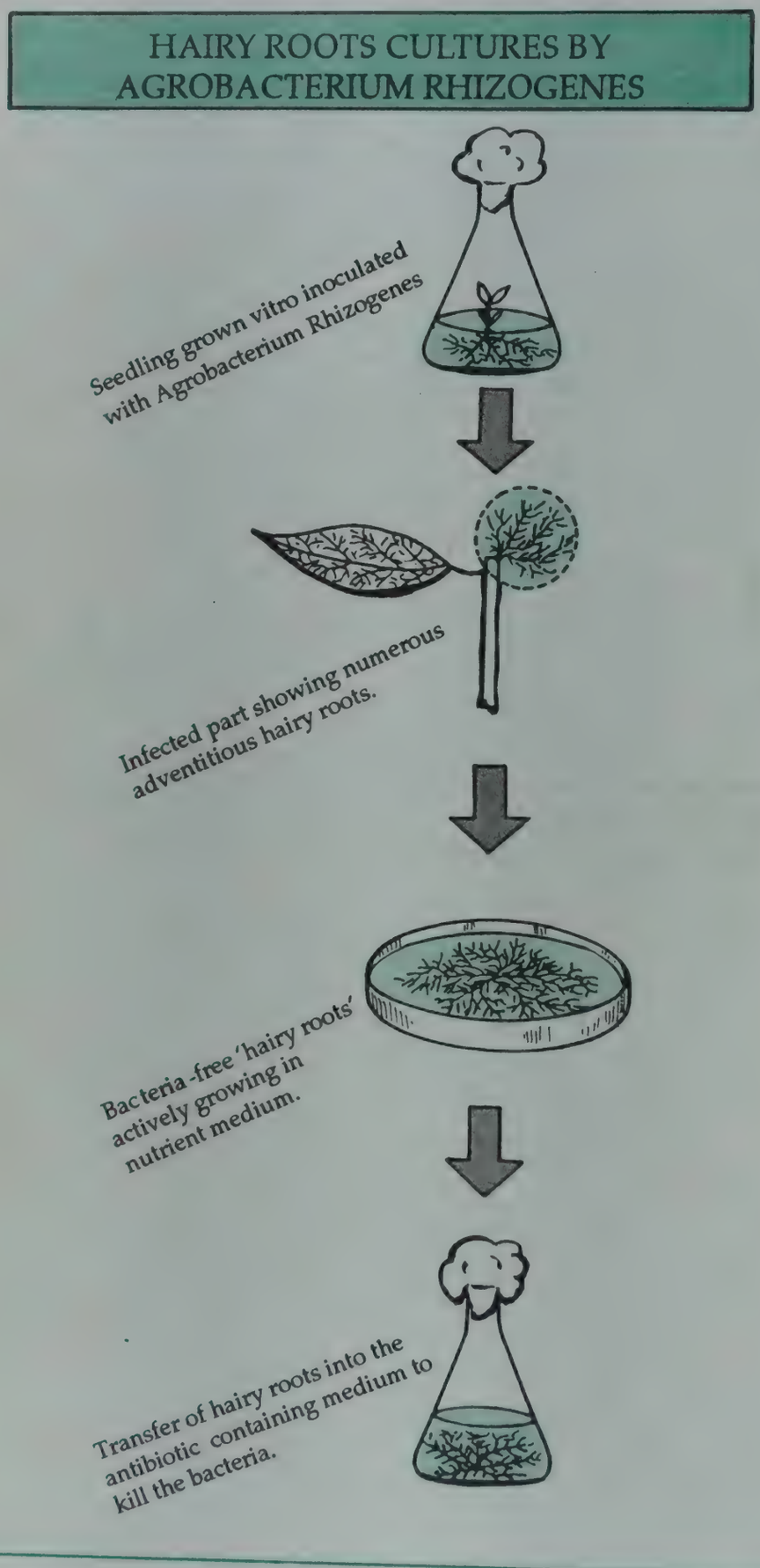
T. SUDHAKAR JOHNSON G.A. RAVISHANKAR L.V. VENKATARAMAN

THE rich tropical vegetation is a source of diverse plant forms valuable for pharmaceutical industries. For thousands of years roots of some plants have provided mankind with specialized biochemicals for use in agriculture, as flavours, dyes, fragrance and drugs. For the extraction of these chemicals roots of plants have been simply pulled out and used. This has led to gradual destruction of many a plant species. The biodiversity convention held in Rio, in June 1992 stressed the need to preserve such useful life forms, particularly in the luxuriant tropical forests. In this context, biotechnology has opened up a new possibility of not only producing useful chemicals from plant roots in unlimited amounts but also conserving the plant species.

It is Phillip White, who in 1934 first cultured isolated root tips of tomato. Since then roots of numerous plants have been cultured for understanding the metabolism, the action of plant growth regulators (or plant hormones) as well as the development of roots. Later one Dawson established root cultures of tobacco in 1942 which produced more nicotine than usual. Root cultures of henbane (*Hyoscyamus niger*) have also been shown to synthesize a chemical called hyoscyamine. These experiments showed the possibility that the root can be a source of plant chemicals even when cultured. However, when fast growing callus cultures and cell suspensions became available in late 1950s, root cultures were largely forgotten. Root cultures have come back in to the reckoning in recent years, thanks to *Agrobacterium* plasmids and genetic engineering. These have helped in overcoming many of the disadvantages of root cultures, sometimes bettering it too.

Root cultures obtained from normal plants grow slowly and consequently produce very low levels of chemicals. In recent years, scientists have developed a technique — of inducing hairy roots — using the soil microbe *Agrobacterium rhizogenes*. This bacteria causes the hairy root disease in dicotyledonous plants. When it infects a plant or plant part, a root-inducing (Ri) plasmid (a small ring of the hereditary material — the DNA) is transferred to the plant cell. This causes the infected plant cell to behave like a root cell and thus numerous, fast growing "hairy roots" are produced. It also alters the production of auxin, a plant growth hormone, resulting in the proliferation of fast growing adventitious roots. The Ri plasmid also carries genes for unusual amino acids called opines, the production of which serves to confirm that transformation has taken place.

Hairy root cultures grow vigorously, producing many lateral branches. Sometimes they grow with rates far exceeding those of simple cultures of roots or equalling that of cell suspensions in culture. Starting with a few milligrams or 1-2 root tips, a typical hairy root clone can grow several thousand folds within three to four weeks. The production of secondary metabolites or the chemicals we are after in hairy roots is very stable and uniform. This is not common in cell suspensions. This is because the


HAIRY ROOTS CULTURES BY AGROBACTERIUM RHIZOGENES
Seedling grown vitro inoculated with Agrobacterium Rhizogenes
Infected part showing numerous adventitious hairy roots.
Bacteria-free 'hairy roots' actively growing in nutrient medium.
Transfer of hairy roots into the antibiotic containing medium to kill the bacteria.

The essentials of hairy-roots technology

chromosome number of the cell in a hairy root culture remains the same as that of parent plant and is not easily disrupted as is common in cultured cell suspensions. These observations led a few groups of scientists in U.S.A. and Japan into using hairy root cultures as chemical factories.

Initial experiments in this direction were done on Solanaceae species which produce tropane alkaloids (Hyoscyamine and Scopolamine). These alkaloids are widely used as antispasmodics in the treatment of gastroenteritis and ulcers to prevent motion sickness. They are also effective antidotes against nerve gas. The hairy root clones of these plant cells grew faster than normal roots and produced alkaloids at the same levels as in a whole plant. Alkaloid production in these cultures, however, decreased dramatically when roots were induced to form callus. Later on, similar hairy root cultures of *Datura* and *Scopolia* were also successfully grown. Cultures of *Atropa belladonna* produce atropine and scopolamine at levels comparable to plants and at significantly higher levels than conventional root cultures.

THE potential of hairy roots for the production of other useful chemicals has also been realised recently in the members of the family Asteraceae, one of the largest groups of flowering plants. The members of this family, like the garden plants daisies and asters are unique and have two major chemical components: sesquiterpene lactones and polyacetylenes. The notable features of these compounds are that they are very active against fungi, bacteria or nematodes and that most of the biologically active compounds are found in the roots of plants. Hairy root cultures from Ambrosia, Bidens and Tagetus have been shown to produce polyacetylene and thiophene. A good number of such plant chemicals have been synthesized so far by hairy root cultures, albeit in experimental setups.

Besides, hairy root cultures have the ability to biotransform xenobiotics.

Back To The Roots

THE root, of all the plant parts, is physiologically and biochemically the most neglected. This is surprising considering their vital functions of uptake of water and mineral nutrients. Besides, they are closely associated with soil microorganisms forming very useful relationships. An example is the intimacy between the roots of legumes and the bacterium *Rhizobium*. Rootsare also a source of remarkable range of useful plant-chemicals.

The pharmacopeias of China and Japan have detailed records of the medicinal uses of roots, from the stimulating properties of ginseng to those of *Lithospermum erythrorhiaon* which produces shikonin used as a dye and antibacterial. The roots of *Valeriana* species have been used as a stimulant and in the treatment of nervous disorders for over 2000 years. Salicylic acid, the chemical model for aspirin comes from the root and bark of *Salix* — the weeping willow. It was used by Greek and American Indians to relieve pain. The roots of ipecan (*Cephaelis ipecacuanha*) known to the Tupi Indians of Brazil, are the source of emetics and expectorant chemicals.

Ginseng, the Chinese wonder root. Its benefits can be reached to many more if the hairy-roots technology is adopted

Agrochemicals like the insecticidal rotenone (from *Derris elliptica*), the alkaloid nicotine and the polyacetylene derivatives of terthienyl and thiarubrin (from *Tagetes*) also are obtained from roots. The alkaloid berberine, used to treat intestinal disorders is found in the roots of *Hydrastis canadensis* and *Coptis japonica*. Forskolin, a labdane diterpenoid chemical isolated form *Coleus forskolin* is a potent activator of the enzyme adenylate cyclase. Reserpine, an alkaloid found in the roots of *Rauwolfia serpentine* is used as a drug for its antihypertensive properties. The alkaloid sanguinarine, extracted from rhizome and roots of blood root (*Sanguinaria canadensis*) is a remedy for rheumatism and periodontal disease. The ginkgolides found in roots and leaves of *Ginkgo biloba* are used to improve brain function and to treat circulation disorders. Plant root chemicals also range from essential oils of sandalwood, sweet tasting principles of licorice (*Glycyrrhiza glabra*) to fragrances of vetiver. These indicate the potential that roots have to turn into factories of biochemicals.

TSJ, GAR, LVV

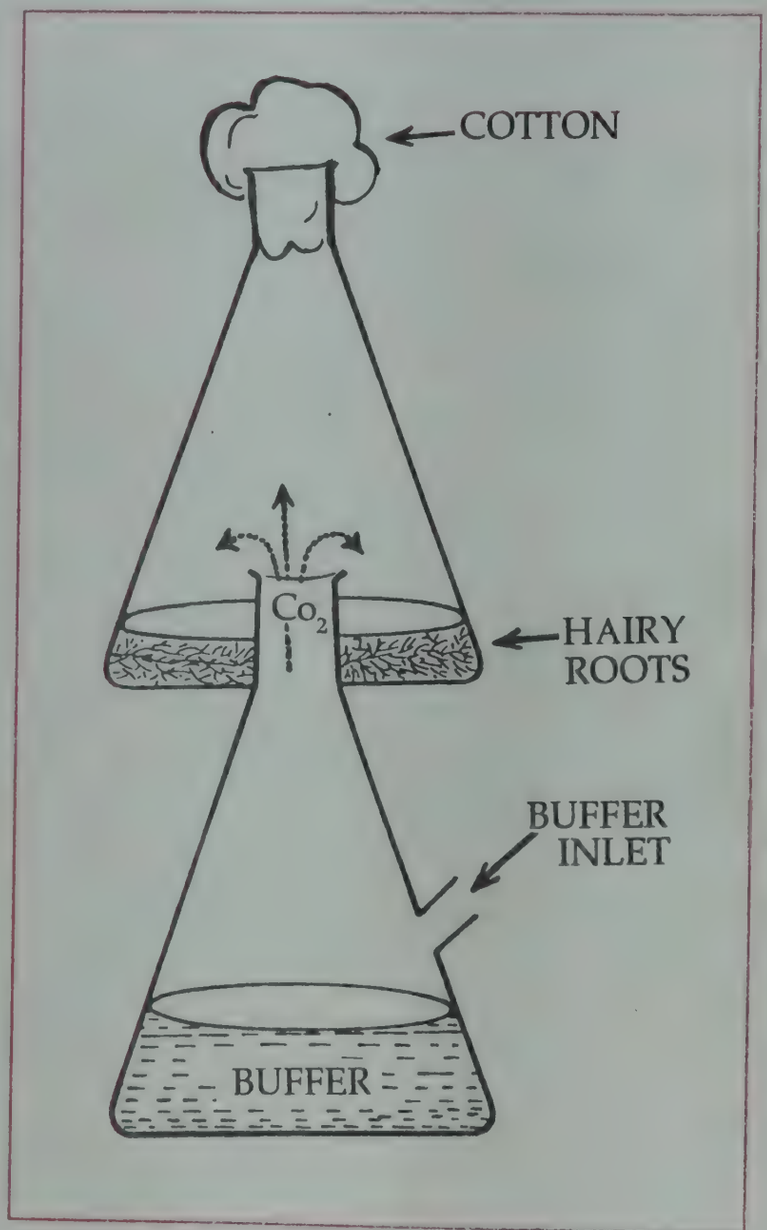
Xenobiotics are compounds not usually metabolised by plants. Several members of Asteraceae can convert butylated hydroxytoluene (BHT) — a common antioxidant used to prevent rancidity in baked food products — into stilbenequinone, a potent fungicide. It is possible to use this approach to search for novel compounds that may have agrochemical or drug potential.

A number of strategies aimed at understanding and manipulating hairy root cultures for increasing their yields have been devised. For example, researchers in Japan have manipulated a key enzyme involved in important biosynthetic reactions. The nicotine in plants is derived from ornithine by the action of an enzyme, the ornithine decarboxylase. The enzyme catalyzes formation of putrescine from ornithine. The gene for ornithine decarboxylase when cloned into roots of *Nicotiana rustica* using *Agrobacterium* as the carrier enhanced the levels of putrescine and nicotine produced.

The root metabolites can also be altered by challenging the hairy root cultures with extracts of pathogens called elicitors. Elicitors are compounds which upon addition to plant cells make them to produce phytoalexins, the chemicals which protect plants from pathogens. The elicitors can be anything from heavy metals (called abiotic elicitors) to fungal or bacterial cell wall fragments (the biotic elicitors). Extracts of *Rhizoctonia solani* a disease-causing fungus made the hairy root cultures of *Hyascyamus muticus* produce large amounts of sesquiterpenes, solavetivone and lubimin, all antifungal compounds. Such elicitors are also useful in elucidating the metabolic pathways, for instance, of polyacetylenes. These fatty acid derivatives contain conjugated polyene and polyine, and are found in over 20 plant families. Interestingly, most polyacetylenes are found in roots. The sulfur containing cyclic acetylenes (thiophenes) found in marigolds, are well known for their nematicidal or worm-killing abilities. Root cultures of

Bidens sulphureus when treated with extracts of a fungus *Phytophthora* gave 20-30 times more of antifungal polyacetylenes within 2 days.

ROOT cultures, in combination with modern analytical techniques and organ culture techniques may contribute to future biotechnological applications. A substantial research effort has been already put in for the production of antitumour alkaloids such as camptothecin, vinblastine and taxol with this technique. Most of these efforts are however, in their infancy. The outcome of these efforts could be enormous. Take for example, Taxol. It is presently obtained from the bark of the Pacific Yew — *Taxus brevefolia* — which can not be easily cultivated. Root organ culture may be a viable alternative for the production of this potential cancer drug, since taxol has already been experimentally produced in cultured yew roots. Recently hairy root cultures of the Chinese medicinal plant *Trichosanthes kirilowii* have been seen producing trichosanthine, a ribosome inactivating protein. The protein, it is said, can inhibit multiplication of the Human Immunodeficiency Virus (HIV) — the AIDS virus. The chemical is also now being tried in animals for the treatment of AIDS.



Hairy root cultures can also be made to synthesize their own food

Roots normally behave as parasitic or heterotrophic organs, and depend on the photosynthetically active stems and leaves above ground for their carbon and energy supply. Normally roots in culture are maintained in dark. Hairy root cultures of *Bidens* and *Tagetes* when grown in light showed a strange behaviour. They turned green, grew faster and produced more metabolites than dark grown cultures. This suggests that photosynthesis contributes to the growth of these green roots. Green roots have normal root anatomy, but also have chloroplasts and therefore can fix carbon dioxide like the leaves do. This can as well be exploited for production of chemicals in roots. The photosynthetic activity of roots is otherwise observed only in epiphytic Orchids.

Hairy root cultures also have another good point, they can be amenable for factory-scale culturing. Any process developed in a laboratory needs to be scaled up for profitable commercial use. The scaling up of plant cell-cultures has not been easy and posed several problems. For example, when scaled up, the cells in culture break, turn slow growing and produce lesser chemicals. They are not also very reliable. It is now hoped that these problems can be overcome to a great extent by adapting hairy root cultures in place of plant cell cultures. Hairy root cultures resist breakage and also grow faster. Moreover, their requirement of culture media is also minimal. The only problem is that the design of culture vessel for scaling up has to be modified if hairy roots are to be cultured. A roller drum design of bioreactor is considered ideal for the growth of hairy roots. The roller drum is rotated continuously and has blades projecting inwards which increase its surface area at the same time preventing the hairy roots from getting submerged in the culture medium. This technology offers a scope for the scale up to industrial level.

In recent years hairy root cultures have emerged as a useful system to study the biology and engineering of plantchemical production. Root cultures, being very stable when compared to disorganised cell cultures, can be a potential source of many low molecular weight compounds, agrochemicals and pharmaceuticals. If shikonin produced commercially in Japan and its application in lipsticks and pharmaceuticals is any indication, a range of root chemicals are about to hit the market in the coming years.

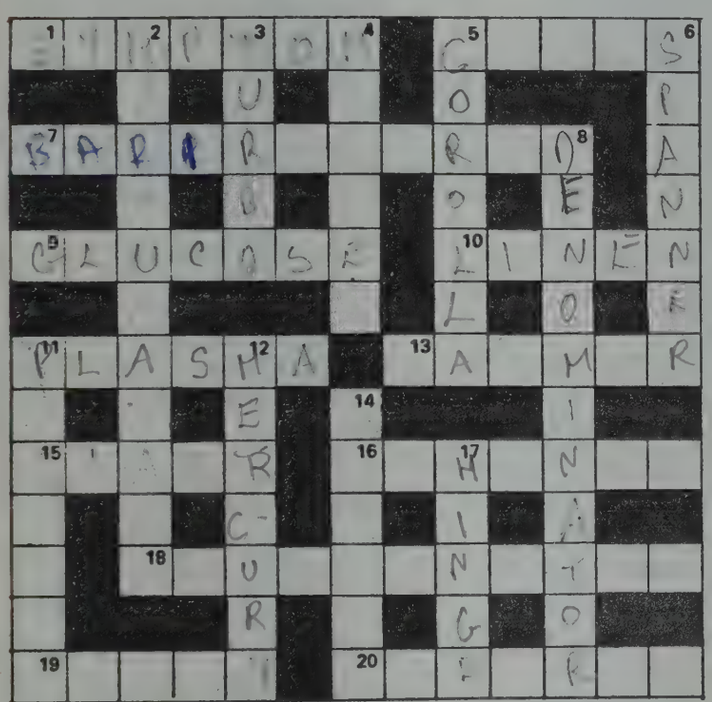
Shri Johnson is a senior research fellow and Drs. Ravishankar and Venkataraman are senior scientists at the Department of Plant Cell Biotechnology, CFTRI, Mysore-570 013

CROSSWORD

VIJAYA KHANDURIE

ACROSS

1. Evidence of disease (7)
5. Largest of the asteroids (5)
7. Electrode having a mesh through which electrons can pass (7,4)
9. Currency of energy production in metabolism (7)
10. Fabrics made from flax fibres (5)



11. Liquid portion of the blood (6)
13. _____series : A group of lines in the hydrogen spectrum (6)
15. A furnace used to remove water from the ore products (5)
16. Loss of voice (7)
18. A small heavenly body of very high density born out of a supernova explosion (7,4)
19. Wanting in muscular tone (5)
20. A mixture of stearic acid and palmitic acid (7)

DOWN

2. The branch of mathematics dealing with the measurement of lengths, areas and volumes (11)
3. _____-dynamo: A d.c. generator directly connected to a high speed steam turbine (5)
4. Paul _____, a Swiss scientist who discovered the insect-killing properties of DDT, for which he was awarded the Nobel Prize (6)
5. Ring of petals forming the cup of a flower (7)
6. Tool for gripping and turning nuts on bolts (7)
8. What is 3 in 1/3 ? (11)
11. Gouty pain in the toe (7)
12. Planet nearest to the Sun (7)
14. Sea-animal, similar to a seal, living in the Arctic regions (6)
17. Piece of metal on which a door turns (5)

(Solution in the next issue)

Solution to August Crossword

B	U	R	E	T	T	E		A	X	I	O	M
Φ		C		H		S	U	N		R		A
R	E	A	G	E	N	T		I	C	I	N	G
E		C		O		E		O		D		N
	C	H	A	R		R	A	N	K	I	N	E
R				E		S				U		S
E	N	Z	Y	M	E		S	C	A	M	P	I
S		O				P		A				A
I	S	O	B	A	R	S		S	T	O	P	
S		L		S		E		C		R		L
T	R	O	U	T		U	R	A	N	I	D	E
O		G		O	R	D		D		E		N
R	A	Y	O	N		O	C	E	L	L	U	S

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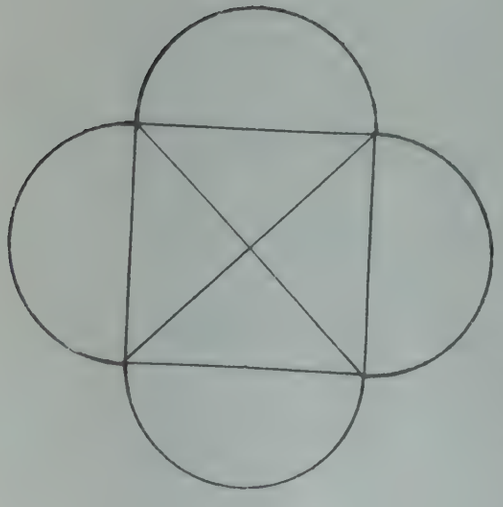
JOURNEY INTO MATHEMATICS

OF BRIDGES, AND NUMBERS..

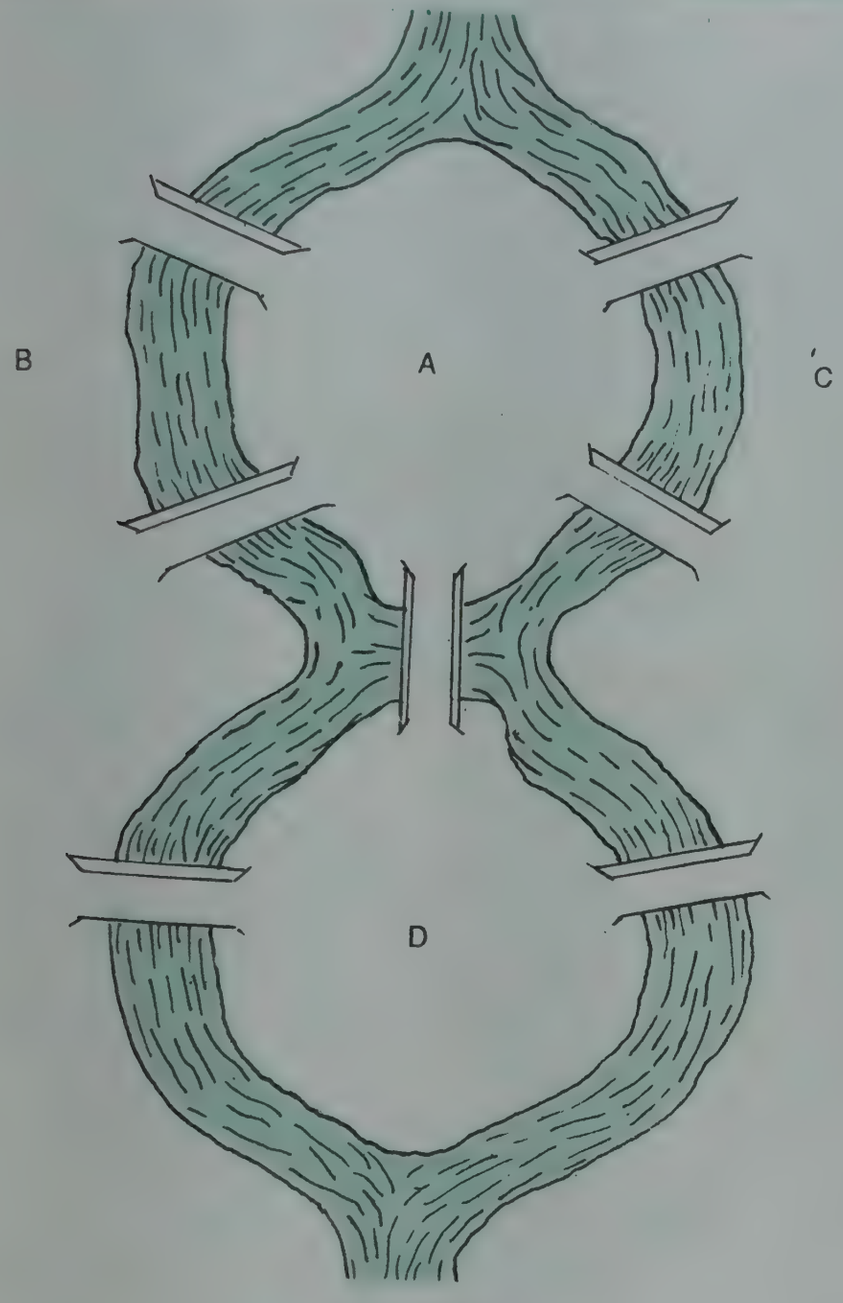


OH! That is a familiar diagram, isn't it. We all have played the game and challenged our friends with it. The game is to trace the lines passing through all the points without lifting the pen and without ever retracing any path. A similar problem had teased the brains of many mathematicians in the eighteenth century. Konisburg in Lithuania (or the Kaliningrad of the erstwhile Soviet Union) is a town spread out on either

NAKUL PARASHAR

side of the river Pregel. It happens that the major chunks of the city are islands surrounded by the branching river. It has a number of bridges that connects the different islands with the mainlands on the two sides of the river. Two centuries ago, there were only seven bridges which formed the crux of a puzzle: Is it possible to walk through all parts of the city crossing each bridge only once and return to the starting point?

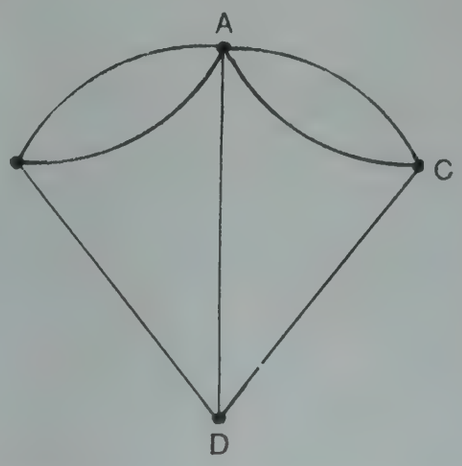
No one in Konisburg practically ever tried to have such a walk, but still people never stopped to ask the question. The puzzle remained unsolved till 1736 when Leonard Euler — the great swiss mathematician and physicist, contributor to the number theory, calculus, differential equations and many other branches of mathematics — proved for once and all that such a walk is impossible. Euler's reasoning was simple. Suppose such a walk were possible and pedestrian did start on it. Any observer on the island A (*see figure*)2 would have seen the pedestrian entering the island and leaving it, a number times. How many times, once? No, because if he visited the island even once the pedestrian would have used two of the five bridges — one for entering into and the second for getting out of it. Twice? Again no, since two visits would mean using only four bridges while there are five. Three times? Certainly no. Three visits would need six bridges,



The Konisburg puzzle

and only five are available. Plainly, then, no such walk is possible! That is how Euler also solved the ancient puzzle. It looks quite simple and obvious, isn't it?

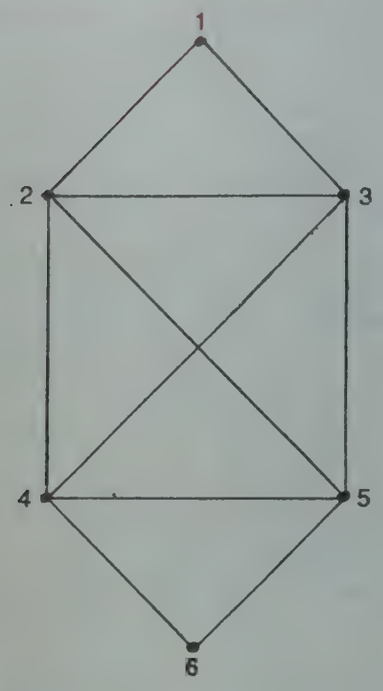
To come to such a solution Euler used a simple method — he literally drew a picture of the problem with points representing the islands and lines representing the bridges. In other words he used a graph. This pictorial representation of a problem or the graph as it is familiar today, turned out to be quite a useful tool in discrete mathematics. In fact, it is also the maths behind the development of some of the most advanced computer software available today. (There is another mathematical tool which is also called a graph, but that is a wiggly line representing a function of a real variable quantity.) A graph is defined as a set of points called vertices connected by lines called the edges. Sometimes edges in a graph point from one vertex to another when they are called as the directed edges. Directed edges can trace a path back to the original vertex. The graph then formed is a closed directed graph. The Konisburg puzzle is such a graph. Well! it is not always necessary that the graph be closed. A family tree, for example, is also a graph. Each generation connected to the next by directed edges. But it is not closed. Such a graph is called a tree.



A single isolated point with no other vertex connected to it could also be a graph. Or a vertex can also be connected to not just one but many vertices. In fact, the number of vertices that a vertex in a graph is connected to determine its degree, or in plain words how difficult the relation between the vertices is.

NOW it is easy to generalize the solution to the Konisburg prob lem. In other words, the solution also called the Euler cycle can be defined as a 'cycle which uses every edge of the graph exactly once'. That means: If a graph *G* does not have any isolated vertex, then it has a Euler cycle if and only if *G* is connected, and the degree of each vertex is even. Finding Euler cycle pictorially, that is in a graph, however, is like catching a hare with bare hands. It takes good amount of time, and ofcourse paper, if a particular graph is being handled for the first time. A computer can also be programmed to solve such a problem by a general algorithm that would proceed systematically.

We begin by representing the graph by what is called the adjacency matrix. The adjacency matrix used '1's to indicate the presence of edges and '0's to indicate the absence of edges between any two vertices. Now take the following figure.



Its adjacency matrix would then be:

	1	2	3	4	5	6
1	0	1	1	0	0	0
2	1	0	1	1	1	0
3	1	1	0	1	1	0
4	0	1	1	0	1	1
5	0	1	1	1	0	1
6	0	0	0	1	1	0

To trace a Euler cycle, let us begin with any vertex, say 1 and trace a path. Now, choose any edge from 1, say 1 to 2 or 12. Change (1,2) and (2,1) entries of the adjacency matrix from 1 to 0 to indicate that this edge has already been used and it is no more available. That is we have crossed one bridge. The result is a *short path* (1 2). The path so far is (1 2) and the new adjacency matrix is:

	1	2	3	4	5	6
1	0	0	1	0	0	0
2	0	0	1	1	1	0
3	1	1	0	1	1	0
4	0	1	1	0	1	1
5	0	1	1	0	1	1
6	0	0	0	1	1	0

Next from vertex 2 we choose the first available edge 23 and delete the corresponding 1's from the (2,3) and (3,2) entries of the matrix. Then from the vertex 3 we take the first available edge 31 and change the matrix. The situation now is as follows. The path taken so far is (1231). That is a cycle and the new adjacency matrix is:

	1	2	3	4	5	6
1	0	0	0	0	0	0
2	0	0	0	1	1	0
3	0	0	0	1	1	0
4	0	1	1	0	1	1
5	0	1	1	1	0	1
6	0	0	0	1	1	0

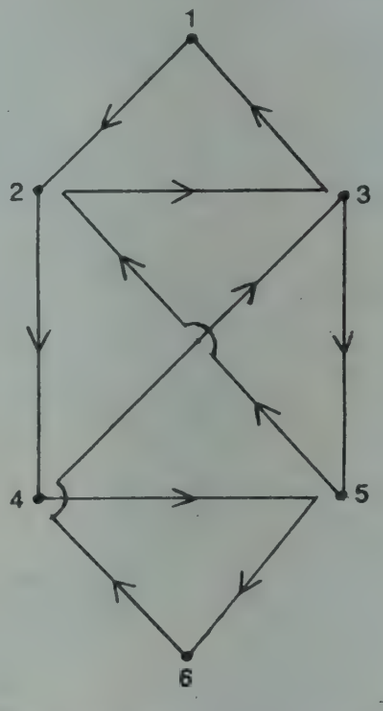
And we are stuck! We have cycled back to vertex 1, but there is no edge available to leave from there. So now we break out by examining the other vertices in the cycle (1231) for an escape route. In this case, we escape via vertex 2 on the edge 24. So we now think of 2 as the beginning of another cycle (2312) and the adjacency matrix remains as before. Continuing in the same way and always visiting the lowest numbered available vertex, we trace paths to vertices 4,3,5 and 2. At this point the situation is: The path taken so far (23124352) (a cycle) and the adjacency matrix as below.

	1	2	3	4	5	6
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	1	1
5	0	0	0	1	0	1
6	0	0	0	1	1	0

Here again we have formed a cycle and must break out if we have to continue. There is no escape via 3, 1 or 2; but the edge 45 is still available. So we choose 4 as the beginning of the next cycle. Then we come to complete the path (43523124) (a cycle) and the adjacency matrix will remain the same as above. Now there is no difficulty in continuing to 5, 6 and 4. Thus we have formed the third cycle also. The path so far is (43523124564) (cycle) and the adjacency matrix as below.

	1	2	3	4	5	6
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0

Thus we have got an adjacency matrix which has only zeros, in other words has no edges left untraversed and we get the desired Euler cycle.



The graph theory has large implications on the future of computer technology as it is one of the major constituents of the mathematics that goes to build a computer — an important part of discrete mathematics. For instance, the simulation techniques like the Program Evaluation and Review Technique (PERT) and Critical Path Management (CPM) which are used in developing hi-tech software use graph theory and Euler cycle. But then we have only seen the cycles, what about the trees is the question that you are itching to ask, is not it? Well, that will be our next destination. Till then ...

(To be concluded)

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HIGH TECH DIVING

ARIAN ABHIJIT BOSE

THE deepest unassisted human dive was made by Italy's Enzo Majorca off Sorrento in 1974, but he surfaced unconscious. So the official record goes to Frances Jacques Mayol who dove 85 metres off Elba in 1973. The deepest diving-bell dive was performed in the French Comex in 1977 — a saturation dive to 460 metres and later to a record 500 metres. But unmanned diving rigs have gone 6000 metres below the surface and many rigs with robot arms are performing salvage work at more than 1500 metres depth today.

Man's quest to reach the bottom of the world as a free diver started in 1943 when two french men Cousteau and Gagnan dove 64 metres feet deep in the Mediterranean with their newly designed Aqua Lung. In 1947, one Fargues of Cousteau's team attempted to reach a record depth on his own — he reached 120 metres when he succumbed to nitrogen narcosis. When his body was hauled up it was found that Fargues had removed his mouthpiece. This tragedy showed that divers should never make deep dives alone and that they should never go beyond 90 metres using compressed air.

In 1945 a Swedish diver, Arnezetterstom, made a pioneering dive to 161 metres using a mixture of oxygen and hydrogen in the Baltic Sea. By a mishap he was pulled straight through to the surface without any decompression stops and he died. This effectively put a stop to the theory of diving with a mixture of oxygen and hydrogen.

In 1948 a British Navy diver, Wilfred Bollard, using a mixture of helium and oxygen dove 164 metres in Loch Pyne in Scotland. In December of 1962 Swiss diver, Hannes Keller, used a diving bell to plunge 304 metres off Santa Catalina island breathing a special mixture Keller wanted to patent. At 304 metresKeller got out to plant some flags at the bottom but dropped them and got back into the diving bell chamber whose hatch had not closed fully, thereby dangerously lowering gas pressure inside. As the bell ascended, one of the two frogmen who went down to close the hatch, Peter Small, died.

In 1972 Comex, an underwater construction company in France carried out a simulated dive to 600 metres in a dry chamber. In 1976 the deepest dive in a Jim Suit was done by a diver belonging tpo the Oceaneering International. In a 1 atmospheric pressurised system he went down to 437 metres off Spain to recover a TV cable. In 1976 itself Dr. Sylvia Earl dove some 480 metres deep sea-floor in a Jim Suit, off Oahu riding the submersible Star II. In 1980 experiments at the Duke University, England, successfully simulated a dive to 650 metres depth in a diving chamber, breathing a mixture of helium, oxygen and nitrogen. These giant pressure chambers can mimic conditions of 47 kilometres in altitude to 1.06 kilometres under water where the pressure is 100 times that on the surface.

SUBMARINES were regarded as purely military vehicles until in 1934 when a bathysphere invented by

two Americians named Otis Barton and William Beebe was lowered on a 940 metre long cable to study the deep sea. The bathysphere was a steel globe containing a porthole and an air supply. The two men were astonished to discover the luminescent sea creatures in the black depth.

The history of the submarine can be traced back to three notables — Bourne in 1578, Drebbel in 1620 and Bushnell's Turtle on its attack on the British flagship Eagle in 1776.

The Englishman William Bourne in 1578 described a primitive submarine in *Inventions & Devices*. Unlike later submarines, this was actually shaped like a boat. Its bilges were filled with leather ballast tanks which admitted seawater through holes below the waterline. When the tanks were full of water, the boat would sink. To return to the surface the leather tanks would be pressed by screws until the water was squeezed out. the trouble with Bourne's submersible was that once underwater, it could not move anywhere. No one knows whether it sailed underwater!

In 1620 Cornelius van Drebbel, a Dutch engineer, improvedBourne's boat as an oar propelled submersible and reportedly took the King of England, James I, for a ride beneath the River Thames. The famous chemist Robert Boyle described it as a leather-covered rowing boat with various chemicals on board that could renew the air inside. These two peculiar crafts were, in fact,250 years ahead of their time.

The egg-shaped Turtle built by American engineer David Bushnel to attack against British ships in the Revolutionary War had screws which propelled the boat backwards and forward. Its up and down movement was controlled manually by the hands of a one man crew, and his legs operated a foot-pump that forced water out of a ballast tank. It carried a mine that was to be screwed into the wooden bottom of the enemy ship. Sergeant Ezra Lee went into action against the British flagship Eagle in New York harbor on September 7, 1776. On arrival Lee got a shock. The entire bottom of Eagle had been sheathed in copper to protect it from wood-boring worms. Turtle backed off after loosening the mine which exploded harmlessly in water. The strange explosion worried the British and they withdrew. New York harbor was saved changing the course of history.

NUMEROUS inventors worked to create an armoured diving suit which would free the diver from any and all problems of pressure. In such a suit he could breath air at normal atmospheric pressure and hopefully could descend to great depths without any ill effects. The barrel diving suit of John Lethbridge was essentially an armoured suit but with limited operated depth and was in reality an atmospheric submersible.

In 1913 Neufeldt and Kuhnke, a German manufacturing firm, patented an armoured diving dress with ball and socket joints in the arms and legs. In 1924 British inventor Joseph Peres built an armoured suit with oil in joints of the articulated arms and legs. In 1935 Jim Jarrat, wearing the "Iron Man" armored suit, located the sunken Lusitania 100 metres under the sea off Ireland.

Modern Jim Suits are named after him. Jim Suits soon became a standard equipment in commercial diving, especially in the deep sea exploration for oil. They were improved by the introduction of Wasp which had built-in thrusters to fly through water, something earlier Jims could not do. Wasps discovered moonscapes under water and could withstand a good amount of pressure. To do an

Undersea Landmarks

1800 Robert Fulton of the U.S.A tested his submarine, Nautilus in France. 70 years later Jules Vernes wrote a science fiction.

1850 Wilhelm Bauer's submarine, Brandtaucher, forced Danish blockaders to retreat from Kiel harbour, Germany.

1864 Confederate submarine, Hunley, sank a US ship Housatonic near Chalreston, South Carolina, and was itself destroyed in the battle.

1887 Desire Goubet of France tested the first battery- powered submarine, Goubet I.

1903 Davis designs a submarine escape lung in England.

1918 Italy developed a human torpedo or chariot and used it in an attack on an Austrian battleship in Pola harbor.

1928 U.S. Navy adopts C.B. Momsen's submarine escape lung with an oxygen rebreather system.

Mid 1941 Italian Navy, after unsuccessful attempts and loss of life, sinks battleships of England in Gibralter and Alexandria. This Gibralter underwater war between British and Italian divers triggered at least on one occasion James Bond movie scenes.

1955 U.S. launched the first nuclear submarine, Nautilus.

1960 USS Triton, another nuclear submarine, followed precise route of Magellan's first journey around the world all through under water. It travelled 560 kilometres every day and took 84 days to go round the globe.

1960 Trieste dived 10 kilometres depth in the Mariana Trench.

1962 French bathyscaph, Archimede, dived 9500 metres in Kuril Trench off Japan.

1966 Alvin, Aluminaut, Perry Cubmarine searched a hydrogen bomb lost near Palomares, Spain, below some 760 metres of water. Itwas recovered by an unmanned CURV (cable-controlled underwater recovery vehicle). ANGUS (Acoustical Navigated Geological Underwater Surveyor) discovered warm water vents at a depth of 2736 metres.

equivalent dive with compressed air would have taken one week's decompression!

On 3 January, 1960 Jacques Piecard and Walsh of the U.S. Navy went down to 11 kilometres of in a bathyscape Trieste in the Marina Trench off Guam and remained for 20 minutes at the bottom. The water pressure there was 1,000 times that of the surface. It had taken them five hours to go down, but it took three-and-one-half hours to surface after releasing the ballast. Jacque's father, the Swiss balloonist, August, had taken up diving anddesigned the bathyscape Trieste like a balloon.

Alvin, a submarine, was built in 1964 — a fat, squat, 25-foot long vehicle which displaced 16 tons and could remain submerged with 3 people at a speed of 1 1/2 knots at 4000 metres. It was the first and only submersible in 1966 to search, and locate a nuclear bomb. Later on Aluminant joined the secret and with the help of CURV — a robot vehicle — recovered the bomb. Alvin exploring the Galapagos rift off Ecuador in 1977 discovered new source of metals in the hot Pacific Ocean rifts 2128 metres below the surface. Recently Alvin also succeded (1986) in photographing the lost, legendary vesel Titanic some 3 kilometres below the Atlantic.

Argo-Jason is a two-stage rig. Argo descends a few thousand feet. It can photograph using advanced strobing equipment that can take pictures in the pitch dark sea bottom. Jason, a small undersea kite, floats out of its holding tank into the sea for a closer look at the survey area. Jason uses six color videos to transmit pictures to Argo's via fibre optics which in them sent to the surface ship to be transmitted via satellites to laboratories.

Deep Rover allowed scientists in 1985 to explore the vast Monterey Canyon off North Carolina, U.S.A. This was developed by Graham Hawkes, the father of Wasp technology. Deep Rover can dive to more than 912 metres and is a revolutionary among the submersibles because it is not tethered to the surface. That means the pilot inside can go just anywhere he wants to.

Small manmade submersibles were built in the 1970's for use in the North Sea outfields. These became obsolete when remotely controlled vehicles became available. Research Submersibles Ltd. founded by Phillip Janca bought two of these submersibles in Scotland and transported them to the Caribbean. After some modifications, these subs have become available since mid-1985 for taking two passengers at a time on a dive to 250 metres along the barrier reef. The viewport is made of thick acrylic plastic and allows photographers to take pictures under powerful floodlights of the sub. The ticket for each person per dive costs 200 US dollars. In 1983 a new company has gone into Bio research with two Edwin A. Link free swimming submersibles that work as deep as 800 metres in collecting marine organisms from Florida and Caribbean reefs. In the past few years unmanned submersibles have become more reliable. Remotely Operated Vehicles (ROV) with articulated arms and claws that can turn valves, cut cables and retrieve tools and such other things have been developed. In 1986 there were 700 civilian units whereas ten years earlier that too mainly in academic and military use. Today they come in many sizes, shapes, functions and price ranges. Deep Rover's manipulators are four feet long arms with sensory feedback capability — that is, the mechanical hands can even sense the texture and consistency of materials they touch. It is therefore, now possible even if with the operator is blind, to differentiate between hard steel, wood, concrete or soft, rubber. These remote operated machines can dive to 120 metres and more at a speed of 1 1/2 knots. They can manoeuver in places where larger units get stuck. One such unit was recently used in the exploration of the Titanic.

McFarlane, head of International Submarine Engineering in British Columbia, is responsible for more than any one in the world today for manned and unmanned submersibles. While Hawke's Deep Rover is a one-man, one-job, one-shift, battery-powered submersible, McFarlane's Sea Shuttle Saga-N is a nuclear submarine with enough hardware and capability aboard to stay below the surface for weeks and travel long distances. His SSS-N will be mother to observers, to saturation divers and to undersea robots.

Underwater Achievements

THERE have been many scientific achievements in underwater technology in the past. Some noted achievements are given here below :

1844 Milne Edwards (44 year old) of France conducted the first underwater marine studies in Strait of Messina off Sicily.

1872 HMS Challenger began three-and-one-half year worldwide oceanographic voyage from England. It discovered the midatlantic ridge.

1892 Louis Boutan took the first ever under water still picture off France.

1899 A remote controlled camera took pictures at 50 metres depth.

1926 William H. Longley at the National Geographic took the first ever artificially illuminated colour photographs off Florida, U.S.A.

1935 Louis de Corlieu marketed the rubber foot-fins in France.

1978 The Research ship, Glomar Challenger, drilled a 760 metres deep hole in the into seafloor Sediment through 7000 metres deep waters.

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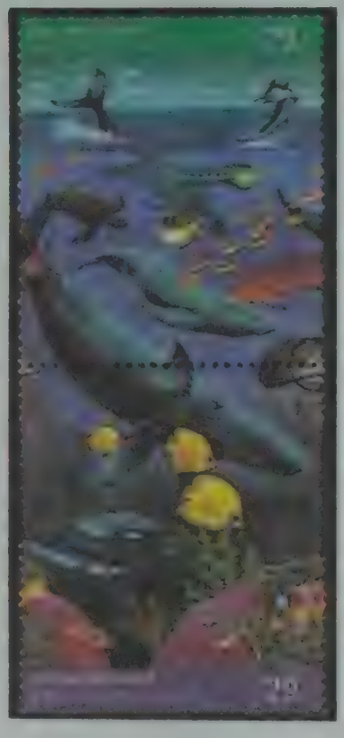
SCIENCE ON STAMPS

CLEAN OCEANS

KABITA ROY

WHAT do we think of when we talk about oceans ? All of us have, perhaps, in our mind a picture of the ocean and what it means to us. Crashing waves, long stretches of sandy beaches, fishing boats struggling to haul in their bulging nets, ships on their daily sojourn and the huge

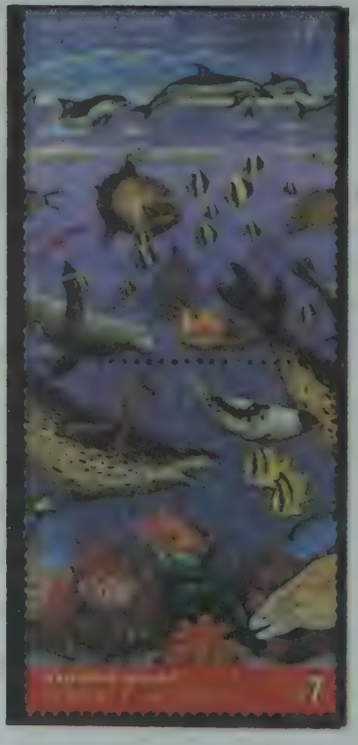


whales—these are the common themes we conjure about the oceans. It is quite an impossible task to confine the sheer vastness of the ocean into a tiny postage stamp. But Braldt Bralds Netherland's famous stamp designer, put his pictures' of the ocean onto paper and thus the rich, vibrant 'Clean Ocean stamps of United Nations came into being on 13 March, 1992.

A decade back the United Nations convention adopted a law of the sea with the objective of establishing a comprehensive legal order to promote the protection and preservation of the marine environment. With 46 articles, the convention

constituted a global framework for measures to be taken by States to keep world oceans and seas clean and healthy. And to project the message stamps have been used as an important medium. Last year United Nations celebrated the 10th anniversary of the convention by issuing these 'Clean Oceans' stamps. It is hoped that the 'Clean Oceans stamps will serve as a reminder to citizens of the world of the importance of pollution-free oceans as the life-sustaining system on the earth.

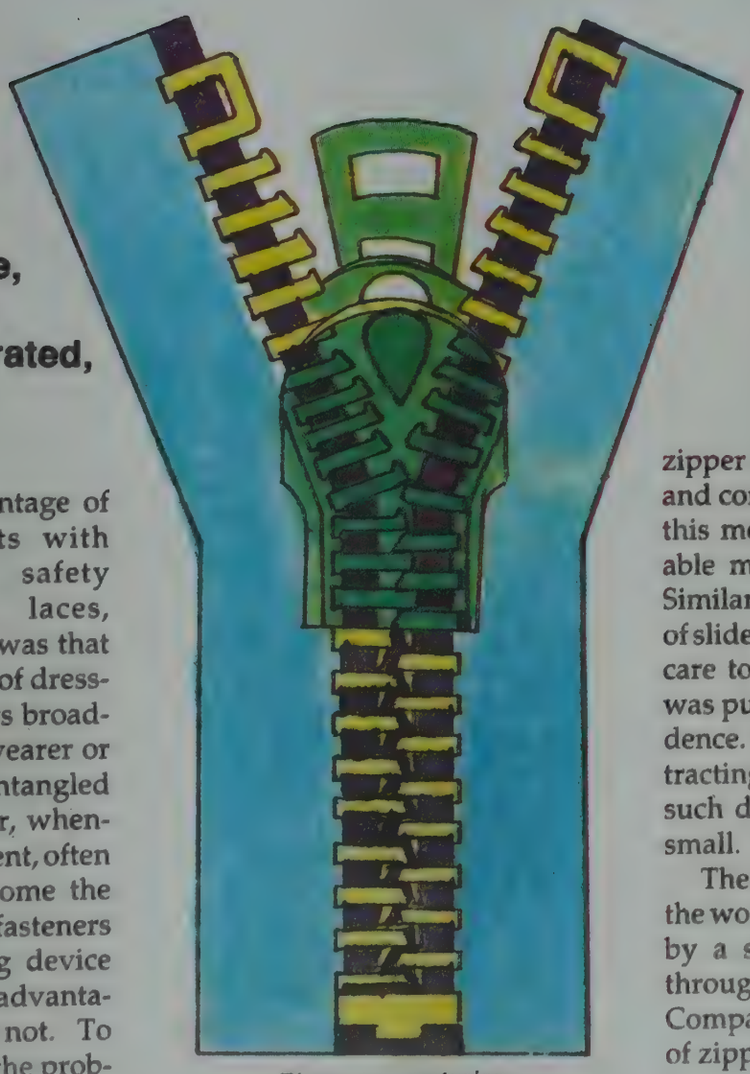
Each sheet of 12 stamps portrays a lush and colourful depiction of marine life. Each of the three designs includes large aquatic creatures, such as whales or porpoises, surrounded by smaller fish and plants. Against the blue tones are strong pinks, yellows and corals that emphasize the luxuriant beauty of sea life. Before even considering the vast scientific data,



these rich visual images alone make a strong argument for the necessity of clean oceans.

100 YEARS OF ZIPPERS

Even after 100 years of its invention this most ordinary, simple, versatile and reliable device goes uncelebrated, says *G.S. RAUTELA*



Zipper — a centurion

THE great disadvantage of closing garments with straight pins, safety pins, buttons, laces, buckles or hooks and loops was that these were lost in the course of dressing, or the holes on garments broadened due to motion of the wearer or left garments torn due to entangled hooks. Though the inventor, whenever he profited from the patent, often believed that he had overcome the failings of the pre-existing fasteners or declared that his closing device was more secure, durable or advantageous, but in reality it was not. To some extent buttons solved the problems of loss, enlarging of holes with more use and they also could not make the closing tight and secure. Nevertheless, buttons on garments became a sign of fashion in 14th or 15th century Europe. The high-button shoes were also fashionable in the 19th century but it took quite some time to button them or open them. This possibly clicked the imagination for the ultimate shoe fastener that opened or closed in a single action.

Something recognisable as a zipper was patented in 1851 by Elias Howe, the inventor of the sewing machine. It consisted of a series of clasps united by a connecting cord running or sliding upon ribs. It was never marketed. Indeed, the zipper, as we know it today, did not begin a fruitful line of evolution until 1893, even though inventors and people from all walks of life were daily reminded of the frustrations of fastening high button shoes. It was Whitcomb L. Judson, a mechanical engineer from Chicago who was awarded the patent for 'clasp lockers and unlockers' for shoes.

Since its invention, the zipper has become the most versatile and common device of today. Yet this most ordinary, simple and reliable mechanism goes uncelebrated. Similarly, the origin and development of slide fastener is a matter few people care to know about. The invention was purely need-based, not a coincidence. However, the chances of attracting the attention of inventors for such devices is often infinitesimally small.

The name 'Zipper' originated from the word 'Zip' which is a sound made by a small object passing rapidly through air. President of the Goodrich Company, that made 'Mystik' brand of zippers, while closing up galoshes in a sales conference, is reported to have replied, 'What we need is an action word — something that will dramatize the way a thing zips.' And then he quickly added 'Why not call it the zipper?' Thus 'Zipper' came to be the common generic name for the device that is more properly called a 'slide fastener, though the word was initially introduced as trade mark by

the rubber company for its "Zipper Boot".

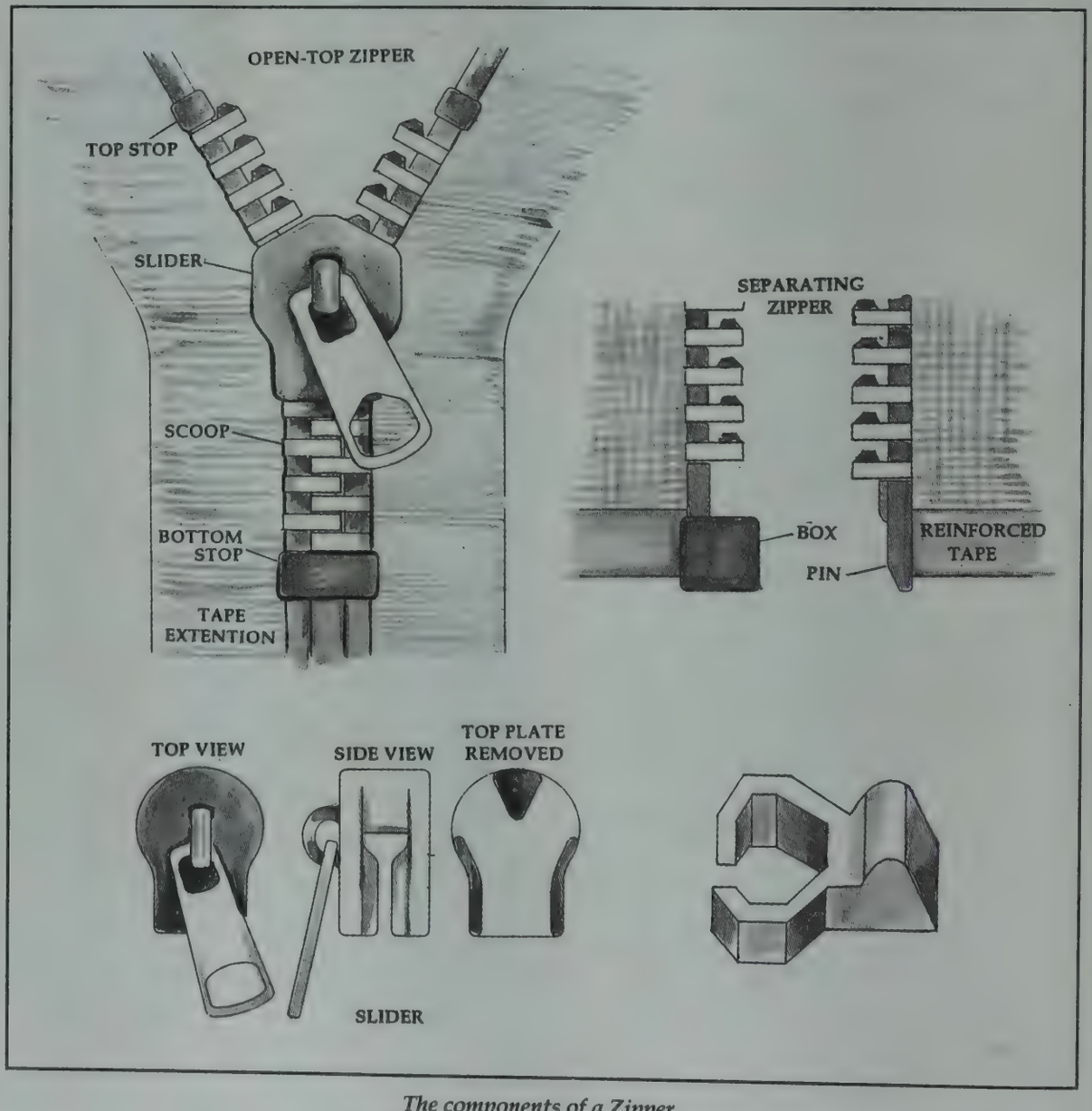
Judson's device for which he received a US patent in 1893 was an automatic closing device actuated by a sliding mechanism. It differed slightly with the modern zippers mainly because of the movement — perpendicular to the opening. However, his invention was a definite evolution from the hook-and-eye fastener, instead of placing each hook into each eye by hand one by one, the wearer could put a tap that brought together the hooks and the eyes. The principle of today's zipper is still the same.

In 1894 Judson and Lewis A. Walker organised the universal Fastener Company to exploit Judson's patents. Walker was a lawyer with a flair for corporate organisation. The Company began promoting one form of fastener under the name 'Universal' in 1896. Sales were poor partly because the fastener had a tendency to pop open under stress and partly because these did not work very quickly as they were stiff. These were also sharp and sometimes tore fabrics that came in contact with them. Moreover, Judson took a year to invent a machine to make his clasp lockers. However, in 1904 the company was reorganised as the Automatic Hook and Eye Co. an offered and improved fastener. The sales of the Company still remained poor but survived by taking on work other than fasteners.

The failures and successes in development of a reliable and trouble free zipper continued until 1917 when Otto Frederick Gideon Sundback, a Swedish Engineer working in Judson's Company, received a patent for a metallic fastener that had all the features of the modern metallic zipper. Sundback's design was based on his realisation that the fastener teeth has to be much smaller. With introduction of these newly designed zippers the business of the Company improved. In 1917 a tailor in New York first introduced zippers in money belts. By 1918 the US Navy had introduced them in clothing. The biggest impetus, however, came from the introduction of slide fasteners in galoshes in 1923 by B.I. Goodrich Co.

A zipper is technically known as a 'slide fastener'. There are two chains of metal, now even of synthetic material, where spirals or ball and pocket devices are attached to a cloth tape. When the protruded portion of the teeth in one chain engages with the recesses in the other, the zipper fastens. It is the slide which brings them together. When the tab of the slider is pulled, each chain is led through the ducts of the slide thereby converging them into a single duct and resulting in an inter-locking of the chains. Opposite movement of the slide seperates the chains.

Till World War II zippers were mostly made of metals. But, improvement of polymers and methods for forming, gave birth to plastic zippers.



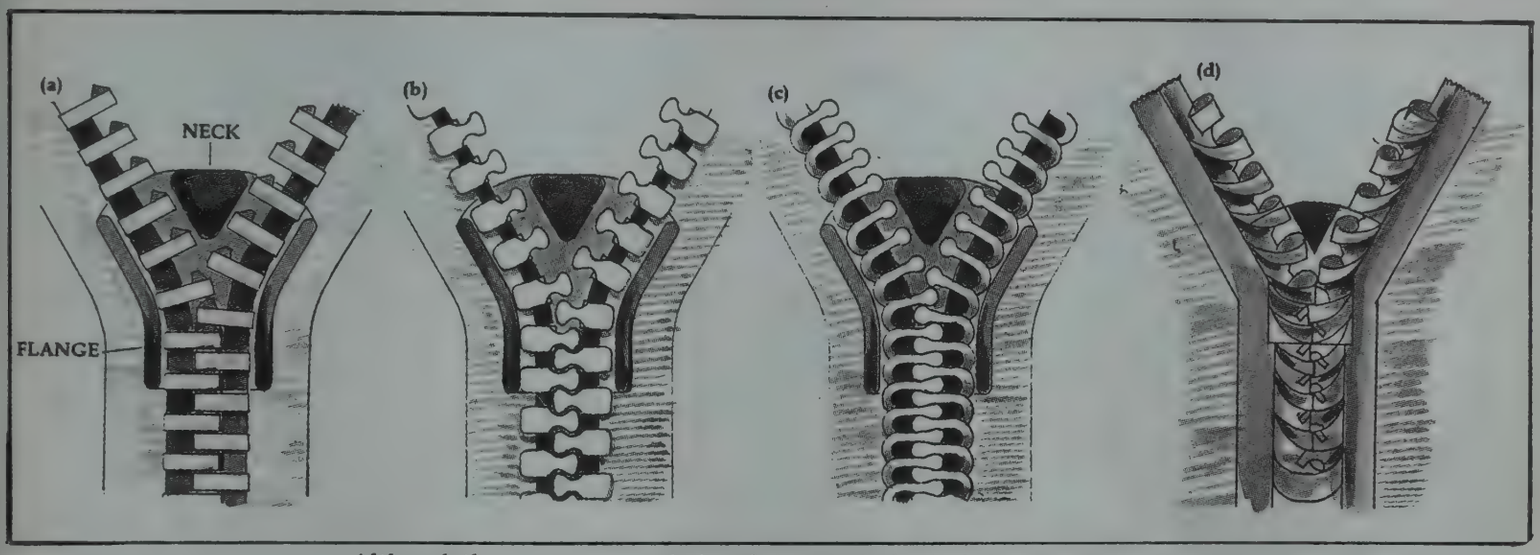
The components of a Zipper

These were first developed in Germany where metal zipper factories were destroyed in war. Spirals, coils, ladders and many other configurations were also introduced in zippers. In some configurations opposing spirals were held together by geometries that differed from ball-and-pocket locking arrangement, but the basic principle of slider based opening and closing remained the same.

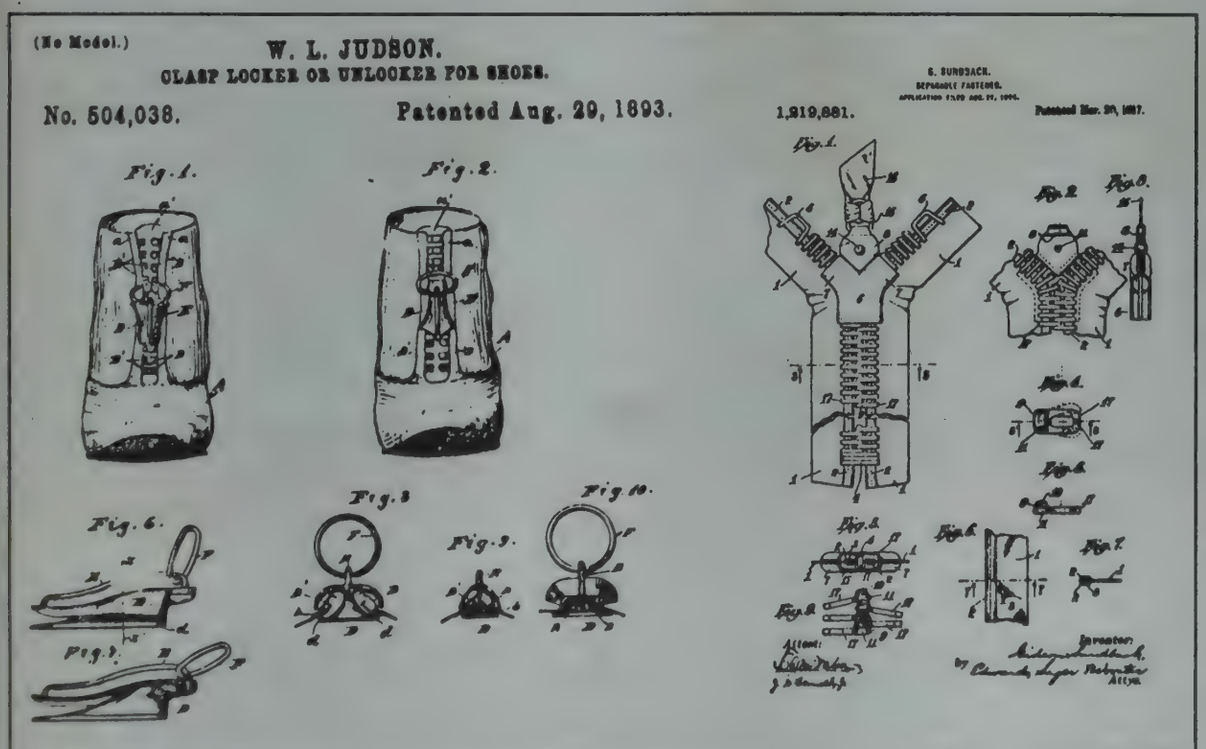
There are mainly two types of zippers — separating and non-separating. In non-separating type two chains are permanently fixed at one end by a joint. Whereas in separating type one end-piece is fixed to keep the slide on one chain while the other is withdrawn. However, there is an end stop for both type of zippers at the other end.

The material for fasteners depends on the end use. Zippers on dresses must be pliable and should not irritate the skin. Therefore, plastic zippers with small spirals are best suited for garments. On the other hand, zippers for heavy luggage must be strong in order to withstand substantial load. Metallic scoops or zippers with strong plastic coils or teeth are preferred for such purposes.

Zippers are the most common of all devices.The key to future development of new zippers shall depend on fresh requirements. Zippers made of synthetic material for use in partitions, curtains or for use in hard materials could be one area of development. Inexpensive and miniaturised zippers for use in papers or polythene bags, airtight zippers for use in suits for astronauts and divers, and air bags, can be other areas for future development. Even airtight zippers made of chemically inert material may be handy to surgeons for replacing stitches after operations especially where the incision needs to be opened again and again for checking the artificial organs such as pace-makers. This will be a challenge for medical investigators and the zipper industry.



Although there are many varieties of zippers, the basic design remains unaltered



The Zipper was born as a clasper for hooks in this patent (left) filed by W.L. Judson. It was later modified (right)

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Garden Spot

B.S. SOMASHEKHAR

LEGENDARY KADAMBA

Kadamba

IT has been with us from time immemorial. In the yesteryears people associated lord Krishna with it; followers of Buddhism worshipped it; poets, artists, sculptors and scholars in the royal courts were greatly inspired by it. It was ascribed with several auspicious values and many legends grew surrounding it. Even today one can find relics of it in several Buddhist monuments. It was so popular that a South Indian dynasty of rulers even was named after this tree. This multifaceted tree which is more heard than seen, is none other than the *Kadamba*.

Kadamba, which is also familiar as Kadam, is an indigenous tree growing wild in the moist deciduous forests of sub-Himalayan plains, Western Ghats and Andaman islands. It is also seen occasionally in big gardens and homesteads. Throughout the country it is called by similar sounding names, which is an indication of its popularity. In Sanskrit, Hindi, Bengali, Marathi and Gujarathi it is called *Kadamba*. In Kannada it is called *Kadamba* and also *Kadawala*. *Kadamba* and *Vellai* are its two names in Tamil. It is known as *Attutek* in Malayalam and *Kadambamu* in Telugu. Botanists name it *Anthocephalus cadamba* and place in the family Rubiaceae, which is better known as the Coffee family.

Kadamba is a medium to large tree often growing to 20-25 metres height with a perfectly straight trunk of about half-a-metre girth. Several branches arise on the main stem in all directions. Uniform in size and stretching horizontally at regular intervals, these slender branches are crowded with leaves. At times it gets so crowded that these branches tend to droop. On the other hand, because of the dense foliage, the tree is able to provide a good shade. Leaves are slightly bigger than those of the Jack tree but are thin, and appear in opposite pairs. Upper surface of the leaves is dark green, shiny and smooth while the under surface is paler in colour and velvety with a soft mat of fluffy hairs. Kadamba sheds its leaves once a year.

Flowering commences in June and continues till August. Flowers of Kadamba are the real 'jewels' that add beauty and glory to the otherwise drab tree. They appear in compact clusters at the tip of the green twigs. Each cluster is called 'head' which, in shape and size, resembles a tennis ball. Each head is made of numerous small flowers of 2-3 centimetres long, which are just as thick as a pencil lead. The main body of the flower comprises five petals which are partially joined to form a long funnel shaped tube. Flowers are golden-yellow to light-orange in colour with a delicate scent. The stigma which is the female part of the flower is cream-yellow in colour and peeps out of the tube when the flower opens. At this stage, the cluster looks like a golden ball embedded with ivory streaks. Such flowerheads dangling

all-over the shiny green foliage make the entire look like an emerald dome studded with golden balls. Aptly enough, Kadamba gets its scientific name from these beautiful flowerheads. *Anthocephalus cadamba* is derived from two greek words: *Anthos* meaning flower and *kephalos* meaning head.

Flowering is followed by the setting of fruits — an equally colourful event. Like flowers, the fruits are also golden-yellow to orange in colour and are eye-catching. These are juicy, slightly sour in taste but with a good flavour. Fruit bats, crows, squirrels and monkeys relish these fruits and help in the seed dispersal.

Even though Kadamba is more admired because of its beautiful jewel like flowers and fruits, it is also prized for its medicinal and other economical properties. Its fruit and bark are potential sources of medicine. A decoction of bark is used by the tribals in Sikkim, Orissa, Bihar and Bengal for treating antifertility. The bark is said to be useful against fever and snake bites, a claim which is yet to be proven. Leaves are often fed to the goats as fodder. The timber is soft and hence mainly used for making boxes, tea-chests and planks. Tribals of the Andaman islands use the wood for making canoes. It also yields a pulpwood which can be used in the manufacture of a lower grade paper.

Kadamba is propagated through seedlings raised from seeds. Since it is practically not economical to raise one or two seedlings, planting material can be procured from the nurseries of the forest departments. Places which experience snow-fall and frost are not ideal for Kadamba as the extreme cold conditions immediately kill the tree. Because Kadamba occupies more space, it can be grown only in spaceous gardens. It may be placed in the lawn or along the walks as a shade tree. It is better not to plant the tree near the houses, as the ground becomes messy and slippery during the fruiting season. The select5ed site should be well drained.

In the desired site a pit measuring one metre in depth, width and breadth should be dug before the coming of rains and filled with sand, garden soil and farm-yard manure in equal proportions. The seedling should be planted during the rains. Staking and proper watering are required in the initial years. Basal branches should be trimmed to develop a prominent trunk. Kadamba grows rapidly and after about 6 years it attains the flowering stage inviting you to enjoy its lively jewel heads.

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A wide stretch of land on both sides of a river in the plains always remains flood-prone and should be kept free of any habitation or construction activity

WHY FLOODS RECUR

(Continued from Page 11)

boundary. This boundary, or the extent of the river's movement about its mean course, is known as the 'flood plain' of the river. For some rivers this zone can be several kilometres wide. Topographically, the flood plain is always at a lower level than the surrounding areas and its more prone to flooding during the peak season. Human settlements and croplands situated within the flood plain are therefore highly vulnerable to flooding by the river.

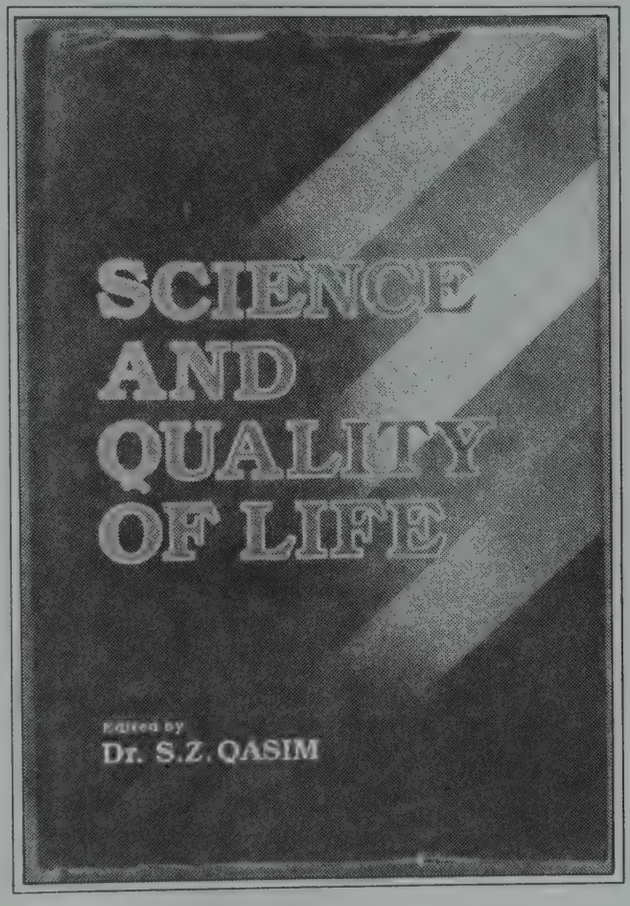
Recognising the importance of flood plain zoning as an effective means of flood mitigation, the Central Flood Control Board had in 1957 mooted the idea of demarcating flood zones and measures to prevent indiscriminate development and human settlement in flood plains. Subsequently, in 1975 a model Flood Plain Zoning Bill was circulated by the Centre to the States with a plea for early enactment of State Laws on these lines.

The model Bill had envisaged that the State Governments should set up flood zoning authorities to undertake surveys for determining the extent of the flood plains of the rivers. It had also envisaged notifying the limits of the flood plain areas on the basis of these surveys. The Bill further called for legislative measures prohibiting or restricting the use of flood plains and removal of unauthorised obstruction by flood zoning authority in flood-prone areas.

Surprisingly, despite the heavy losses they incur due to floods every year, the State Governments have preferred to remain passive about the Bill. In fact, even after eighteen years, Manipur is the only state to have enacted legisation on the basis of the model Bill. A bill on the issue is said to be under consideration of the West Bengal Government, while some other States like Madhya Pradesh and Andhra Pradesh are reported to have 'accepted in principle' the necessity for enacting the legisation. It is alleged that "apart from submitting almost invariably exaggerated estimates of the losses caused by floods and asking for huge relief contribution from the Centre, the States have done precious little to control the floods". The problem has a political dimension too. Legislators are known to be apathetic to schemes which go against their interest, even at the cost of putting the common man at risk. It is known that State Government officials often encourage private contractors and real estate dealers to construct human settlements in the flood plain of a river. In Delhi, right under the nose of the Union Government, the Delhi Administration has been promoting human settlement in areas which come under the flood plain zone of the Yamuna river. If such violation of clear-cut guidelines continue, the problem can never be solved. What is needed is a concerted action by all concerned—from intensive reforestation to strict flood plain zoning regulations—to make this annual ordeal a thing of the past. □

Better Life With Science

THE prime objective of any development activity is ostensively to improve the quality of life of the people at large. But, then, how does one define quality of life ? Can it be measured by some quantitative indices like the consumption of steel, aluminium or energy, per capita income or the growth rate of the GNP ? Economists and planners world wide have been using these indices to define the standard of living, but of late it is being increasingly realized that it is not enough to address issues of human life in terms of quantitative numbers alone; there is much more to it. So when Dr. S.Z. Qasim, General President of the 80th Science Congress chose "Science and Quality of Life" as the focal theme of the Congress, he decided to look at the subject in its entirety, from various angles. To do that he invited experts — distinguished scientists, technologists, social scientists, planners, industrialists, even administrators to present their points of view which have been put together in this information packed volume*. The fifty articles in the book are grouped into six sections. The topics covered range from the commonplace health and population matters to frontier S&T areas like space, biotechnology and information technology.



For a populous and developing country like India the importance of planning for balanced development cannot be over emphasised. "Careful planning can give significant results in human development even with moderate levels of income," says Shri Pranab Mukherjee, then Deputy Chairman, Planning Commission, in his paper entitled `Planning for Quality of Life'. "...the pattern of development of the western world is already proving to be non-sustainable from ecological point of view." For India, he says, the western pattern of development will not be feasible and not all technologies considered essential in the West may be quite relevant for us. "Science offers the potential for taking a fresh look at these technologies and to develop innovations that suit our local conditions of producting more, using less of basic resources...Perhaps, it is science, and science alone that will open up the path for sustainable development," he says.

Looking at the health scenario, which is an important indicator of the quality of life of any people, Prof. J.S. Bajaj, Member, Planning Commission, notes that despite many successes since Independence in terms of rise in life expectancy, fall in infant mortality, and spread of health care services, there still lurk "some of the stark realities", which need more attention. For instance, "Half of the total number of people afflicted with tuberculosis in the world, and a majority of those with leprosy, live in India...Maternal mortality is still unacceptably high." He ascribed this to poor utilization of the health and family welfare infrastructure by the people.

Dr Vasant Gowariker, former Advisor to the Prime Minister on Science & Technology brings out interesting facts about population dynamics in his paper 'Improving the Quality of Life for Billion Plus Indians'. According to him there is utmost urgency for the implementation of two components related to quality of life-literacy and available energy. Only then, he says can the numbers become a productive resource. But before that can be achieved, he warns, our runaway population growth must be checked. "Perceiving the various dimensions of the problems of human needs and the quality of life," he says, "one gets fully convinced that unless the question of population control is aggressively pursued and some stability is achieved, a real improvement in the quality of life is difficult to accomplish."

The Council of Scientific and Industrial Research is one of the oldest scientific bodies engaged in research aimed at improving the quality of life through the application of science and technology. Be it in the field of food, housing, health or environment, or in frontier areas like electronics, new materials or biotechnology, CSIR's contributions have been notable. "CSIR laboratories", says Prof. S.K. Joshi, Director-General, CSIR, in his paper, "have taken special care to

undertake projects which will lead to an improvement in the quality of life of our people".

Biotechnology is another area which has made rapid inroads into our daily life and holds great promise for the future. Dr. V.L. Chopra, Director-General of Indian Council of Agricultural Research in his paper, 'Biotechnology for Agriculture in India', enumerates the many successes achieved in improvement of crops and livestock through biotechnological means. He says, methods have also been standardized for producing transgenic fish through expression of growth hormone genes micro-injected into the eggs of commercially important fishes which has increased their growth rate by as much as 20% giving bumper catch in a relatively short time.

The use of biotechnology in improving the nutritional status is discussed in a paper authored by Dr S. Ramachandra, former Secretary, Department of Biotechnology and B.M. Gandhi of the same Department. Through better understanding of the biological pathways of food crops and applications of biotechnology, they say, it would be possible to produce food crops which are not only disease and pest resistant but which also produce grains with superior nutritional quality.

New materials such as ceramics, composites and advanced polymers have revolutionized technology encompassing a wide spectrum of sectors like transportation, power generation, architecture, aerospace, communication, microelectronics and bioengineering to name a few. Stressing the crucial role of new materials in shaping India's future, Prof. C.N.R. Rao, Director, Indian Institute of Science, says, 'advanced materials is one area where the benefits of R & D will eventually reach all of mankind", but in his view "the research effort itself will be concentrated in a few countries advanced in science and technology". Dr. P. Rama Rao, Secretary, Department of Science and Technology, on the other hand suggests the constitution of an autonomous National Advanced Materials Research and Development Board to speedily develop capability in this vital area. "Unless we develop capabilities in this sector", he says, "we will be left behind in the vital field of high technology which is so important for improving the quality of life of our people.

Notable among others who have contributed to the volume are Prof. M.G.K. Menon, Prof. D.P. Chattopadhyay, Dr M.S. Swaminathan, Prof. P.N. Srivastava, Dr N. Seshagiri, Dr S. M. Kulshreshta and Dr. Harsh K. Gupta. The spectrum of subjects covered in this volume is truely vast and the issues raised are highly relevant. It is hoped that the volume will provide valuable inputs for scientists, technologists, planners and policy-makers and help them take the right decisions to make tomorrow's India a better place to live in.

Biman Basu

***SCIENCE AND QUALITY OF LIFE:** edited by Dr. S. Z. Qasim, *published by* The Offsetters, New Delhi (1993); Pp. 620 + xii, Rs. 600.

THIS FISSURED LAND : An ecological History of India *by* Madhav Gadgil and Ramachandra Guha, *Oxford University Press* (1992), 2/10, Ansari Road, Daryaganj, New Delhi-110002 Pp xiv + 224, Rs 290 ISBN 019 -563027-o

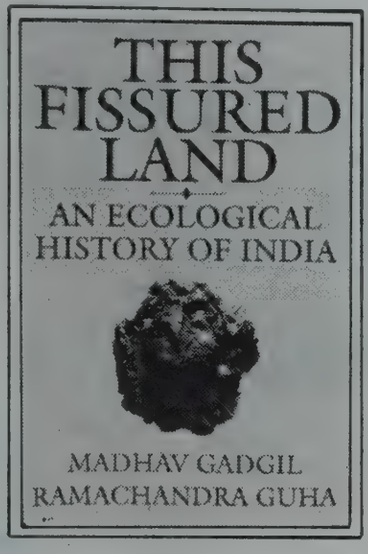
WHERE should we look for the roots of our ecological crisis ? Some, such as the historian Lynn White, trace it to the beginnings of the Judae-Christian tradition itself; others exonerate it, and point an accusing finger towards the industrial revolution, urbanisation, capitalism and the like. In this pathbreaking volume, the authors look at the complex history of India and her colonial experience, and demonstrates how the traditional system of religion and caste taboos had put restraints on exploitative and destructive practices; and how the action of the colonial state broke down these traditions of restraint and dispossessed the traditional custodians of the forests.

The book consists of three parts, each of which deals with a seminal question: Firstly, what are the conditions under which human beings can be expected to be prudent in their use of natural resources, and conversely, when are they profligate ? Secondly, what are the forces of production and their interrelationships, especially the technological infrastructure, property rights and belief systems which legitimise and validate the interactions of humans with nature ? Thirdly, how do differing strategies of resource use give rise to social conflict and how can these be minimised ? These questions are placed in the specific sociocultural and historical context of the subcontinent and the analytical framework provides an ecological interpretation for the origin and persistence of the caste system in India, which will complement the economic and ideological interpretations of this them as an organising principle in the Indian context. Finally, the utilisation of the "mode of resource use" the supplements the more common "mode of production" analysis as a framework for historical periodisation.

Part I, then, is a theoretical framework. Human history is here divided into four distinct modes of resource use : Gathering (including shifting cultivation), nomadic pastoralism, settled cultivation and industry. Each of these is analysed with respect to specific aspects such as technology (energy sources, materials used, knowledge base relating to resource use), economy (spatial scales of resource flows and modes of resources aquisition), social organisation (size of social group, division of labour, mechanisms of control over access to resources) and finally ideology (perceptions of man-nature relationships and specific cultural practices promoting conservation or destruction). These result in characteristic distinctions in the nature of the environmen-

tal impact between the different modes, and characteristic forms of social conflict between as well as within the different modes.

This analysis by means of resource use modes provides some special insights. For instance, the similarities between capitalism and communism or socialism appear to be more significant than their differences when viewed from an ecological perspective. There are structural similarities between these two systems in the scale and direction of resource flows, the technologies of resource exploitation, resource management (or rather mis-management) practices with their emphasis on the short term, and above all, in the human ideologies.



India, in the authors' words, is a "fantastic mosaic" of the different modes of living and resource use modes. Here village blacksmiths coexist with nuclear reactors and integrated steel plants; hunter-gatherer societies are found within a few kilometers of sophisticated urban centres. The resources demand and use pattern of this mosaic are equally varied. In the past, there were restraints to over-exploitation of the environment in terms of customary prohibitions and rights: — Sacred ponds and groves which preserved diversity and provided refuges for plants and animals, customary rights of grazing, fishing and forest produce collection which reduced conflicts and alleviated pressure on resources. All of these are breaking down under the pressure of modernism, and population growth; there are few animals and hunting grounds, pastoral and forest lands are increasingly degraded and shortages in firewood, groundwater, and in infrastructure of power and transport are increasing. These acute shortages in turn give rise to severe social conflicts, and marginalisation of traditional users. To a great extent, we are living on borrowed time.

Parts II and III of the book examine the ways in which this socio-cultural and ecological mosaic of Indian society came into being. Part II offers a fresh look at the historical origins of Indian society. The conflict between the Aryans and the "Rakshasa" in the Ramayana and Mahabharatha eras are presented as conflicts between the traditional forest dwellers, at the hunter-gatherer stage, and the Aryan pastoralists and agriculturists. The *Yagnas*, especially, are seen as deliberately destructive practices in which huge amounts of firewood and animal fats are consumed, thus depleting the resource base of the traditional forest dwellers. The Brahmins are seen as pioneering colonisers in the forest, establishing outposts and initiating forest destroying rituals, which the Kshatriyas rushed to defend when opposed by tribals.

This interpretation, however, is open to considerable doubt. the traditional Puranic depictions of the Rakshasa in no way implies that they were technically inferior to the Aryans. On the contrary, there is considerable awe at their magical cities, wonderful weapons and so on. The Yagnas, however profligate, could not do too much damage to the forests in view of the very low man-to-land ratios prevalent in those days. In any case, animal fat was not consumed in the Yagnas. Rather the consumption was of ghee, a pastoral product, stored up over the year. The view of Vedic religion as ecologically destructive is also too facile, given the specific injunctions in the Atharva Veda and elsewhere on protection of the earth and of all living species. Many such objections could be thus raised but in any case the authors do provide a new interpretation of the historical evidence.

Part III looks at ecological change and social conflict in modern India, from the advent of colonialis. Colonialism introduced a decisive break with the earlier pattern of "selective incorporation". The emphasis shifted to "conquest and control" whose weight was felt heavily by the forest dwellers, though no group of society was able to escape.

India today stands at a critical juncture, wtih many points of conflict between different modes of resource use. The traditional rights have been eroded, and the practices which have replaced them are more attuned to profligacy rather than conservation. There are important issues of social justice, and equity, which are intertwined with issues of conservation. Indeed, it is being increasingly recognised that environmental protection and sustainable development cannot be achieved without social justice, community participation, protection of traditional rights, and indeed their enhancement by a system of empowerment of the rural poor. there are few conflict-reducing mechanisms emerging. Since the true basis of the resource-based conflicts is not understood by the policy makers, the new approaches being formulated are unlikely to lead to sustainability and conflict reduction. It is here that the important of this book lies it is an important and timely contribution to the understanding of the historical process by which the present pattern has come into being.

S. Mohan

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MADHU SAHNI

Fighting Malaria

MALARIA—one of the most dreadful diseases in the world, affects nearly half the world's population, but drugs available to fight it are rapidly losing their punch. Nearly 2 million people die of malaria every year. More than 300 million people suffer the painful cycle of fever, chills and sweating which comes after being infected by one of the four kinds of malaria-causing *Plasmodium* parasites, which make their way from the saliva of an infected mosquito into red blood cells of a human being. Since 1960s the situation has gotten worse rather than better because *Plasmodium* parasites have become increasingly resistant to the commonly used drug quinine and other related drugs. But now there appears to be a ray of hope. Recently reports have come of the successful testing of a new class of drugs for treating malaria and of a promising new vaccine for preventing it.

The new antimalarials are, however, not strictly new. For thousands of years, the Chinese have been using the original source of these drugs, a medicinal herb called *qinghao*, first as a cure for hemorrhoids, later as a way to treat fever, including a malarial one. Antimalarial ingredient in *qinghao* is an extract, called quinghaosu.

The plant whose botanical name is *Artemisia annua* is the source of a chemical called artemisinin which is poisonous only to *Plasmodium* and a few other microbes.

Chinese doctors have been using artemisinin for a long time, but because of little scientific exchange between China and the rest of the world, this work was not known to other countries. The other reason may have been economic, because the plant produces artemisinin in very small quantities, not economical enough to produce enough to solve the world's problem of malaria.

In India, the plant was introduced in 1990 by the Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, from the Royal Botanical Garden, Kew, England. At present, it is cultivated in Kashmir valley. Efforts are being made to produce artemisinin in large quantities and at a much cheaper rate to make the country self-sufficient in the drug.

Artemisinin was first synthesized in the lab in 1983 but it had little medical impact, because it involved at least 15 chemical steps. It was too time consuming, too costly and too laborious. It was not viable for large scale production. So chemists and physicians are trying to develop a simpler chemical which is equally effective against malaria but easier to make than artemisinin. Gary Posner, a chemist of Johns Hopkins seems to have found a way. He stripped down the chemical structure of the Chinese drug to its bare bones and simplified it so that its synthesis involved only six or seven steps. He and his group focussed on the active ingredient in artemisinin, a six-cornered ring called trioxane which consists of three carbon atoms and three oxygen atoms. The key part of the trioxane molecule is the link between two adjacent oxygen atoms in the ring, a peroxide linkage. Peroxides, like hydrogen peroxide which is an antispetic, cause oxidation. The peroxide group in the trioxane probably acts on malaria-infected cells and causes oxidation

which leads to the destruction of the cells. But trioxanes alone are not sufficient to cure a person of malaria. Because unlike the complete artemisinin molecule, they are unable to pass through a cell's fatty membrane. So Posner and his group took trioxane rings and attached a series of different appendages on them, with the hope of getting a simple compound that can still pass into a cell and attack the parasites within. So the researchers synthesized 25 different trioxane, derivatives.

The Watter Reed Army Institute of Research in Washington, D.C., tested the compounds by placing them in a test-tube with malaria-infected cells. Out of the 25 synthetic compounds, eight turned out to be at least as good as artemisinin at killing the parasite and some were even better. Encouraged by these results, the Army tested these drugs on malaria-infected mice and two of these emerged as bonafide mouse-malaria cures. Tests on monkeys also confirmed the efficacy of the two drugs. After a few more years of arrival testing, the new drugs would be ready for safety testing in humans.

The other encouraging report comes from Bogota, Colombia, where a team of researchers have developed new vaccine against malaria. The team led by Manuel Elkin Patarroya of the Immunology Institute of Hospital San Juan de Dios in Bogota developed the vaccine containing bits of synthetic non-infectious proteins which mimic four different proteins from the surface membrane of *Plasmodium falciparum*, the species of parasites which causes about 95% of all malaria deaths. One of the four proteins is found in the parasite when it is in its larval stage, the stage at which it is injected into the blood stream of a human being by the mosquito. The other three forms of protein are from the next developmental stage, during which the parasite actually infects red blood cells in the body.

Patarroya and his group administered their vaccine to 738 volunteers from La Tola, on the Southern Pacific coast of Colombia. It was found that there were 39% fewer cases of *falciparum* malaria among the vaccinated group than among the controlled group. Two groups fared particularly well. There were 77% fewer cases of malaria in children between 1 and 4 years and 67% fewer cases in volunteers over 45 years old. Subsequent trials with the vaccine gave much better results.

According to the researchers, although 39% protection rate is not extraordinary for a vaccine, one has to remember that 39% of 2 million malaria deaths a year is nearly 8,00,000 lives a year. That's a lot of lives saved if the new vaccine becomes universally available and works as well as in the trials.

Ms Sahni is a scientist in the Publications and Information Directorate, New Delhi

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